AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Headquarters of the Society: Saint Joseph, Michigan

RALPH U. BLASINGAME, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 18 MARCH 1937 NUMBER 3

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Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . . The title AGRICULTURAL ENGINEERING is registered in U. S. Patent Office. Copyright, 1937, by American Society of Agricultural Engineers.

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HYATT

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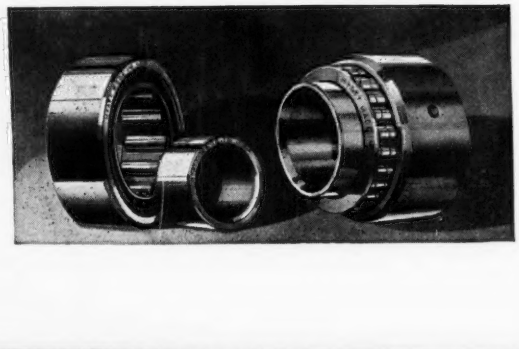

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AGRICULTURAL ENGINEERING

VOL 18, NO 3 EDITORIALS MARCH 1937

Fundamental Research in Conservation

FOR an extensive and intensive effort to get new quantitative information as a basis for improved design and practice, we commend the watershed and hydrologic studies of the USDA Soil Conservation Service, described elsewhere in this issue by W. D. Ellison.

As analysis of soil and water conservation problems has progressed, it has isolated, qualitatively, numerous individual factors and interrelationships determining the nature and solution of those problems. Conservation at the point of precipitation requires new and more detailed information on the nature and amount of precipitation, and on the interaction of soil, water, vegetation, and other influences before the water and water-born soil get into large streams. Existing information on streamflow, construction materials, and construction practice no longer suffice.

While this has been realized for some time by engineers in soil and water conservation, the problem of getting the desired information has been one of staggering proportions. The weather factors are both variable and uncontrollable. Vegetation is a comparatively new element in engineering. Watershed patterns, both at and below the surface, are complex, never exactly identical, and not susceptible to artificial duplication.

The Soil Conservation Service has pictured the hydrologic cycle and is installing equipment to measure the values of its individual factors under different combinations of conditions. Comparison of results under existing farming practices, and under the influence of current soil and water conservation measures should give some early indications of their relative effectiveness and reasons therefore, along with information on which to base new and widely applicable engineering tables, formulas, design, and practices.

Current designs for dams, terraces, etc., based on existing information and some good or bad guesses on points where facts are not available, will continue to serve well until more information is available. Where emergency situations demand immediate stop-gap measures, on which engineering information is not complete, some trial and error work must be done. But the whole experience of science and engineering shows that when basic information is finally obtained, notable economies and improvement of results are achieved. They are benefits to be expected of the watershed and hydrologic studies, and which no lesser effort in the field of soil and water conservation research could achieve.

Research Equipment Aids Tillage Progress

MARK the engineering of tillage tools as entering a new phase with the development and application of full-scale testing equipment as described by I. F. Reed, in his paper beginning on page 111 of this issue.

Since man first learned to stir the soil to the end of producing more and better food, inventors have done a creditable job, as inventing goes, of providing new and better means of stirring it. But scientific study of soil has put empirical design on its last legs, as far as tillage tools are concerned.

M. L. Nichols, his associates, and others have made a sound start in the analysis of physical properties of soils and their relation to both plant growth and tillage operations. They have provided scientific justification for the necessary investment in full-scale testing equipment.

If this equipment was used only to make comparative tests of the performance of empirical designs, it might be worth its cost. But its major purpose and value would be lost. The big thing it can and will be used for is to check theoretical analysis and laboratory results; to warn scientific thought of any errors as soon as they appear, and to help it determine the fundamental what, why, and how of tillage which is the only sound basis for further improvement in tillage equipment and practices.

"Conservation or Floods"

Editor of AGRICULTURAL ENGINEERING:

IT SEEMS to me that whoever wrote the editorial "Conservation or Floods" in AGRICULTURAL ENGINEERING for February flew on the wings of rhetoric far from the field of engineering. In particular, I take exception to statements like "whether to abandon the lowlands, and eventually the uplands, to the destruction man himself has initiated," and "whether to fight floods as small trickles in the uplands or as raging torrents in the lowlands."

The historical fact is that floods occurred along the Mississippi and its tributaries long before civilized man entered into the picture. The engineering fact is that it will be necessary to fight raging torrents in the lowlands regardless of all the fighting of trickles in the uplands.

Understand that this is not written in a spirit of opposition to sane conservation, but rather is a criticism of nonethical ballyhoo. Floods, soil erosion, forests, and common sense are all interrelated, and unless the approach to conservation problems is rational, real progress toward solution will only be impeded. Let conservation problems be considered by engineers on the basis of facts. I feel that as a society of engineers we can ill afford to give voice otherwise.

D. G. MILLER

Senior drainage engineer
USDA Bureau of Agricultural Engineering
Mem. ASAE.

Tillage, Soil Structure, and Agricultural Engineering

Editor of AGRICULTURAL ENGINEERING:

IN THE February 1937 (vol. 29 no. 2) issue of the Journal of the American Society of Agronomy, Prof. Richard Bradfield of Ohio State University, writing on the subject, "Soil Conservation from the Viewpoint of Soil Physics," says "We have learned to turn to the engineer whenever we find ourselves in difficulty. In the past I feel that the agricultural engineer has been able to see the temporary tilth which he created with his machines, but he has been unconscious of the effect produced by the continuous use of these machines over a long period of years. *There is no question but that the final results of tillage operations as we now know them is to make the structure of soil worse.*"

In another place he offers the explanation, "Every time a tillage implement is forced through a soil countless granules are crushed as a result of the strain generated during the tillage process. As the granules are crushed, the primary particles composing them are obliged to take up new positions in the soil mass. In many cases they clog the pores between the remaining granules, forming an impervious layer which Lowdermilk and others have found to be such an important factor in increasing runoff and erosion."

As remedies he suggests the development of "tillage implements which will accomplish our ends without having such a harmful influence upon structure. This problem is certainly worthy of the serious attention of the agricultural engineer. The second possibility is to reduce the number of tillage operations to a minimum."

He speculates concerning a machine which would create the ideal structure, and further speaks of "agricultural engineering technics in connection with drainage, irrigation and, under certain conditions, of terracing."

If we accept Prof. Bradfield's contention that tillage has the ultimate effect of making soil structure worse, should agricultural engineers assume the responsibility of a long time viewpoint, as regards the physical conservation of our soil?

LAWRENCE M. NULL
Power farmer and implement dealer
Colchester, Illinois,
Jun. Mem. ASAE

WE FEEL safe in saying, for agricultural engineers as a group, that they welcome this friendly challenge, as well as the implied compliment on their past performance. Several considerations come to mind.

Relegating hillside soils to forest and pasture is only a partial solution. There are, in the agricultural regions of North America, considerable areas of comparatively level lands. There are also markets for many farm products which we do not yet know how to grow economically without tillage. Until farmers are shown some better way of making a living from year to year, these areas will be actively cultivated.

If tillage necessarily destroys desirable soil structure, agriculture seems due for longer crop rotations, including more years of perennial grasses. This seems to be about the best general recommendation that can be made at present. It is expensive from a cash crop viewpoint, but this is undoubtedly a lesser evil than soil depletion.

But this is no answer satisfactory to research men, either in soil science or agricultural engineering, as long as unknowns remain in the relation of soil to plant life. Research men will ask "Why gear agriculture down permanently to alternate periods of production and soil improvement as long as there remains a possibility that these two functions can be accomplished simultaneously?"

It has not yet been proven that the purposes of tillage can be accomplished only by means which necessarily have a net destructive effect on soil structure.

The fundamental research approach to the tillage problem, it seems to us, is not to argue cultivation pro and con, but to study the soil as a physical, chemical, and microbiological medium for the growth of agricultural plants. That is called soil science.

No agricultural engineer worthy of the name advocates tillage primarily because it involves machinery within his technical domain. Agricultural engineers, however, are definitely interested in the economic handling of soil for improved net results in the production of farm crops, by application of all possible scientific facts and principles. They are interested to the extent of wanting to work with soil scientists in every way possible to help increase the fund of scientific soil knowledge.

When the necessary basic knowledge is available, machine improvements, or new machines, if necessary, and new agricultural engineering recommendations as to economical farm practices, from both a long-time and a short-time viewpoint, will follow naturally.

Improved Farm Implements Then

Editor of AGRICULTURAL ENGINEERING:

SOMETIME ago in looking over some books in a second-hand book store I ran across a report of the Department of Agriculture dated 1866. This report contains an article entitled "Improved Farm Implements" by S. Edwards Todd, New York City. The article contains a discussion of a variety of subjects, one of which is entitled "Agricultural Engineers," and I am quoting what he has to say on the subject of "agricultural engineers," which I believe should be of interest to the members of our Society:

"What wonders have been wrought in farm implements in the brief space of forty years! The young men of our country cannot appreciate the great contrast between a complete set of farm implements forty years ago and the hand tools, implements, and machinery required at the present day to constitute a full set of implements. Forty years ago a farmer could carry all the tools required on a farm of ordinary size, in an ox-cart, at one load; but to-day, the tools and machinery on that same farm cannot be transported in six ox-carts. Let us, for a moment, direct our attention to the implements for gathering a crop of grain, and preparing it for market. Then, a cradle worth $2.50, and a rake worth twenty-five cents, a flail fifty cents, and a fan for cleaning the grain worth $1, was about all that was required; but, today, the mower, and reaper, and the threshing machine must be brought into requisition. Almost every operation must be performed by efficient and complex machinery, requiring years of practical experience to manage with skill and efficiency. Almost every operation is performed on the farm by some kind of implement, which requires more wisdom, judgment, and discretion to put it in order and to keep it from getting out of order, than an engineer exercises in running a steam engine.

"We are a nation of scientific inventors. Every week or every month, developments in labor-saving machinery are given to the world, that astonish everybody. The man who launches forth in some new enterprise, flattering himself that the world will stand aghast before his profound wisdom, is almost overwhelmed with chagrin at the thought that some live Yankee is close at his heels with an invention which will eclipse the brightest feature in his machine. As men become familiar with the laws of matter, and acquaint themselves with philosophical and mechanical principles, they discover how easy it is to make an application of their knowledge in improving some of the implements of agriculture."

C. E. RAMSER

Increasing the Farm Use of Electricity

By H. J. Gallagher

TEN years ago it was a generally accepted fact that agriculture would be a big user of electric energy if the proper kind of equipment for farming operations was available, and service could be extended at a reasonable cost. To extend service at a reasonable cost meant reductions in both the cost of construction and the cost per kilowatt-hour. Determining how electric energy could be used on the farm, and the proper kind of equipment for those uses, became a research program of national scope.

The problem of building sturdy, low-cost lines has been solved to the extent of rendering service to 788,795 farms between 1926 and 1936. During this time the cost per kilowatt-hour has also been greatly reduced until at the present time agriculture is receiving service at costs undreamed of a few years ago.

The research program on electric application has developed over 150 uses for electricity that have practical application on the farm. The equipment for these uses has been designed, manufactured, and is on the market.

Thus the essential premises on which the success of farm electrification was originally established have been satisfied. What has been the response of agriculture? What do the records reveal?

I will use Consumers Power Company of Michigan as a background, not because we necessarily think we have the answer, but because I prefer dealing with concrete rather than abstract examples, and the load building problems of all utilities have many points in common.

We have been extending rural service for a number of years. Our records for the past 10 years show that in 1927 we were serving 1,299 farm customers, the average annual consumption was 440 kwh (kilowatt-hour); the average cost per kilowatt-hour was 9.34 cents, and the annual revenue per customer was $41.10. On December 31, 1935, we were serving 18,460 farm customers, the annual consumption was 751 kwh, the average cost per kilowatt-hour was 3.77 cents, and the annual revenue was $28.37. Reducing the cost of energy 59.6 per cent resulted in increasing the use of energy only 71 per cent, and a reduction in revenue of 31 per cent. To have kept pace with the rate reduction, the consumption during 1935 should have been 972 kwh instead of 751 kwh. The high peak of consumption was 755 kwh in 1929. Those figures rather definitely discount the theory that lowered rates are the basic requirement in building load. Rather, they emphasize the necessity of associating better load building programs with reduced rates, to maintain an equitable revenue.

What has happened during this period of ten years to have kept the annual consumption on so low a level? It is true agriculture has been in financial difficulties, but usually when an industry is in distress its first move is to reduce operating costs. Obviously agriculture didn't attempt to use electricity in this respect. This gives rise to the following questions:

1 Do farmers appreciate the value and economy of electric operation?

2 Is electricity a factor in reducing the costs of farming operations?

3 Are we trying to sell the farmer something he can't afford?

4 How much can the farmer afford to invest electrically?

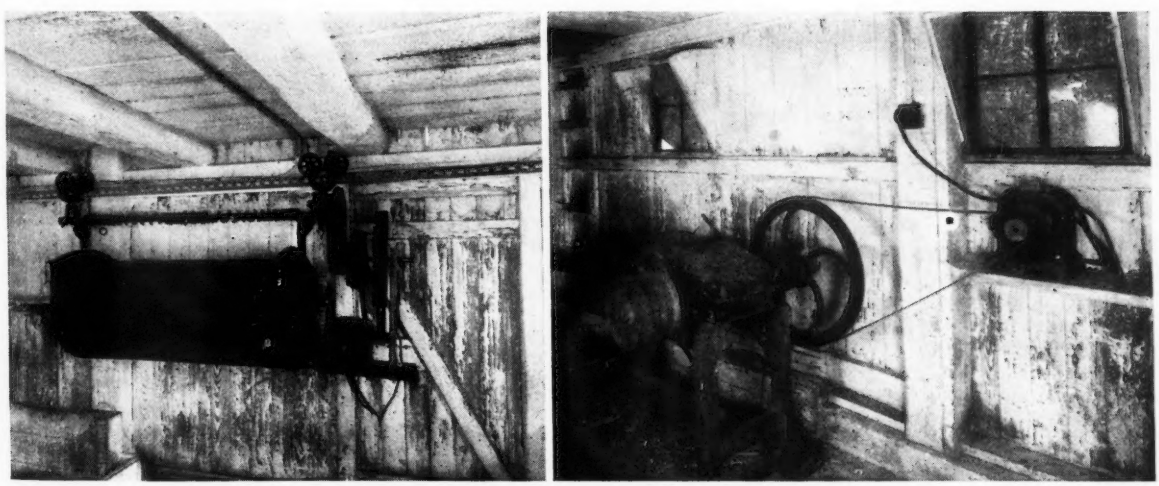
5 What should be the annual consumption on the average farm?

6 What is an average farm?

Familiarizing the farmer with the value of electric operation is strictly an educational program, scheduled for later discussion. Regardless of the kind of educational program pursued, it is important that it be concentrated on the right group. Any group of customers may generally be divided into three classes. In the first class will be the

Presented before the Rural Electric Division of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1936.

Author: Farm service supervisor, Consumers Power Company. Mem. ASAE.



(LEFT) LITTER CARRIER WITH ¼-HP ELEVATING MOTOR. (RIGHT) A 1-HP MOTOR RUNNING A FODDER CUTTER

aggressive type, the leaders, who carry on without much assistance. Approximately 3,000, or about 15 per cent of the 25,000 farm customers served by our company are in this class. Another class would be those who can go but a very limited way with any program. It is estimated that this group is also about 15 per cent of the total.

Between the two extremes are the great bulk of the so-called average customers, living and farming on average farms, in this case about 19,000. This is the group that will profit through educational programs, and that will make educational programs profitable to the utility.

What is this average farm? How large? What are the farming practices? What is the total investment? What per cent of the total investment would be a reasonable electric investment? To what extent will the farm income support electric operation?

In an attempt to answer these and similar questions, an analysis was made of the farms in the agricultural areas of the lower peninsula of Michigan. This is shown in Table 1.

TABLE 1. VALUATION ANALYSIS OF AVERAGE FARM

80 acres at $60.00	$4,800.00
10 cows at 80.00	800.00
3 horses or tractor	500.00
100 hens	125.00
Hogs or sheep	75.00
Machinery, tools, etc.	1,500.00
Total	$7,800.00

On this average farm, or any farm with electric service, are uses that may be classified as base uses, as shown in Table 2.

TABLE 2. BASE USES OF ELECTRICITY

Base use	Equipment cost	Average kwh per year
Lights		360
Radio	$ 50.00	120
Pumping	100.00	360
Washing machine	65.00	48
Iron	6.00	120
Toaster and percolator	10.00	120
60-amp service wiring	150.00	
Total	$381.00	1,128

The $381 electric investment is less than 5 per cent of the total farm investment, but measured by the yardstick of an annual consumption of 751 kwh, the investment would be nearer $250 than $381. Consequently, even the base use is inadequately supplied to the extent of about 33⅓ per cent.

To electrify the more common agricultural practices on this farm would result as shown in Table 3.

TABLE 3. COMMON ADDITIONAL USES OF ELECTRICITY

Use	Equipment cost	Year kwh
Burr mill, 4½ in, grinding 18 tons of grain	$ 7.00	360
Motor, ½ hp	27.00	
Other uses for motor besides grinding		60
One 300-chick brooder	25.00	150
Two poultry water heaters	5.00	75
Portable milker	125.00	180
Portable dairy water heater	20.00	360
Total	$219.00	1,185
Base use (Table 2)	381.00	1,128
Total	$600.00	2,313

In this case an electric investment of $600 is only 7.7 per cent of a farm investment of $7,800, and compares favorably with the investment in the automobile or the household furniture. The resulting $6 monthly electric bill may or may not appear formidable, depending upon whether it is incorrectly considered as an additional expense to the farm, or correctly considered as a better substitute for present expenses.

Ordinary monthly expenses on the farm where electric service is not available are shown in Table 4.

TABLE 4. OPERATING EXPENSES WITHOUT ELECTRICITY

Items	Average per month
Kerosene for lights	$1.00
Gasoline for pumping and other chores	1.00
Radio battery charging	0.50
Grinding (18 tons grain per year)	3.00
Brooding chicks, for oil and coal	0.75
Total	$6.25
200 kwh at 3 cents	6.00
Difference	0.25
Loss in egg production: 11 per cent basis (Ordinarily computed on 30 per cent basis)	2.75
Resulting difference	$3.00

Or considering the time, expense, and labor saved in milking, the utility use of the motor, water heater, iron and washing machine as the equivalent of $2.75, the resulting difference between electric costs and nonelectric costs would be $3, which in turn is 6 per cent interest on the $600 invested for the equipment and wiring in Table 3.

All farms naturally would not have the same agricultural characteristics. Some would be more inclined to poultry than dairy, and vice versa. Others may be of an entirely different type. It makes little difference. From over 150 practical uses of electricity on the farm, a proper selection may be made to stay within the limits of a reasonable investment, do the work that is done by other methods, and effect sufficient savings or earnings to more than offset the monthly bill.

If the farm is more inclined to poultry than to dairy, the dairy equipment in Table 3 is replaced by additional poultry equipment as in Table 5.

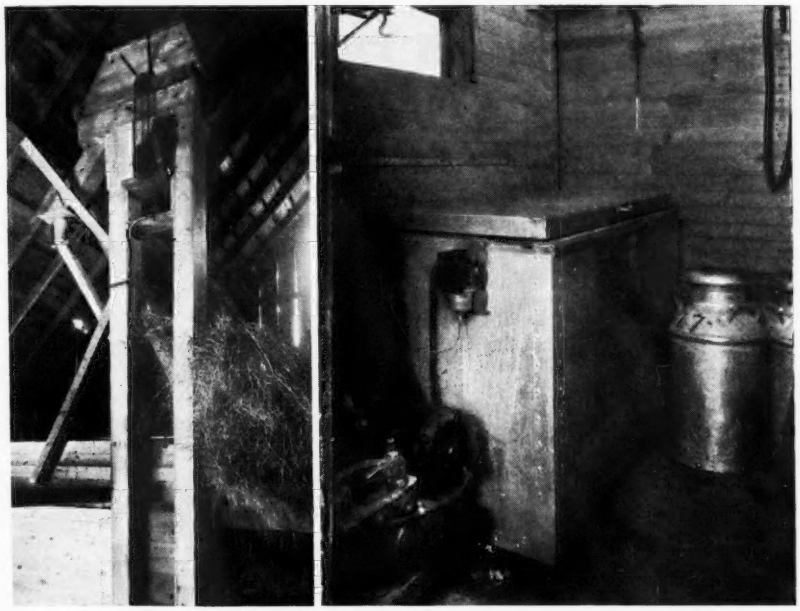
TABLE 5. ELECTRIC USES ON POULTRY FARMS

	Equipment cost	Year, kwh
Grinding (remains about the same)	$ 7.00	360
Motor, ½ hp	27.00	60
Incubator 600-egg	125.00	300
Two 500-chick brooders	80.00	500
Poultry lights	15.00	90
Poultry water heaters	25.00	375
Total	$279.00	1,685
Base use (Table 2)	381.00	1,128
Total	$660.00	2,813

Where the major operation is dairy, the poultry equipment of Table 5 may be replaced by dairy equipment as in Table 6.

TABLE 6. ELECTRIC USES ON DAIRY FARMS

	Equipment cost	Year, kwh
Motor, ½ hp	27.00	60
Grinding (remains about the same)	$ 7.00	360
Milker	125.00	180
Immersion cooler, 6-can	300.00	1,000
Portable water heater	20.00	360
Total	$479.00	1,960
Base use (Table 2)	381.00	1,128
Total	860.00	3,088



ELECTRIC POWER APPLICATIONS

(Extreme left) A bucket type grain elevator installed in the barn of the Ernest Pruehs farm, Utica, Michigan. (Left) Electric motor operated 2-can milk cooler on the Paul Malburg farm, also at Utica

A common practice on many farms is to milk by hand, sell cream, brood a few chicks under hens, and raise a few acres of small fruits and vegetables. The poultry and dairy equipment can be replaced by other equipment more applicable to this farming program as shown in Table 7.

TABLE 7. ELECTRIC USES ON SMALL COMBINATION DAIRY, POULTRY, FRUIT, AND VEGETABLE FARMS

	Equipment cost	Year, kwh
Porous hose irrigation system for 3 acres	$100.00	
Centrifugal pump	30.00	
Motor, ¾ hp	60.00	
Water pumped, 270,000 gal		500
Milk separated, 60,000 lb		60
Soil heating cable, 240 ft, and thermostat	41.00	
Operation of heating cable for 20 days		320
Grinding equipment	34.00	420
Total	$265.00	1,300
Base use (Table 2)	381.00	1,128
Total	$646.00	2,428

Similar illustrations could be made to apply to all types of Michigan diversified agriculture. Based on an average annual consumption of 751 kwh, the average farm customer has an electric investment, including wiring, of less than $300; an additional investment of about $300 in equipment is more than justified from a production or from an earning standpoint. The electric range, the refrigerator or the storage water heater have not been included in this analysis. Of course, they are a definite and very important part of farm electrification, but these three major units should not be held so close to the eyes that sight of other important possibilities is lost.

Information of this nature tends to establish a goal, an objective to work toward. It provides a fund of information to present to merchandising agencies interested in the rural electric market. It dispels numerous arguments as to whether the farmer can afford electric operation or not. It emphasizes the fact that farmers have to spend money to farm; that if the amount they normally spend for poor electric substitutes were converted into electric operation, it would be of mutual benefit to the utility and the customer.

If this analysis is correct to the extent that the average farm can afford and should invest an additional $300 in electrical equipment other than domestic, we have an immediate market on 19,000 average farms, totaling 5.4 million dollars.

How is this market to be supplied? Who is going to do the job? These questions have bothered utilities, manufacturers, and dealers since the beginning of rural electrification. I do not know the answer. As far as our company is concerned, we do not merchandise farm equipment, not even water systems. We are cooperating with local dealers and manufacturers in the development of the farm market. Last spring it was my pleasure to discuss this subject in nine sectional meetings of the Michigan Retail Hardware Dealers Association. This group is interested in rural sales and the better appreciation they and all other dealers have of the farm market, the better results we can expect in getting equipment on the lines. At the present time we have nine agricultural engineers in the field whose job it is to correlate these activities and assist the farmer with his electric problems. These men are employed on a straight salary basis. They do not sell merchandise; rather they sell the value of electric service.

We find that the dealers are beginning to do a better job of selling; they attend local educational meetings, furnish equipment, and assist with demonstrations. They are also beginning to carry a more complete line of motors and a greater variety of other equipment.

Each week a report is released to the newspapers throughout the territory showing where new lines are to be built. This provides all the dealers an equal opportunity to promote sales.

This is but one phase of a load-building program. Advertising, methods of merchandising, demonstration farms, group meetings, motion pictures, radio broadcasts, and local news releases are other factors in the utility load building program. Beyond all of the activities of the utilities, however, are the far-reaching effects of the educational programs of the extension divisions of the land-grant colleges. Most of these institutions have incorporated rural electrification as an educational project. As leaders of agriculture they appreciate the many social and economic advantages of electric service in improving the living and working conditions on the farm.

Prevention of Silo Gas Accidents

By D. J. Price, H. E. Roethe, and M. A. Bradshaw

EARLY in September 1936 three lives were lost on a Maryland farm when a mother and her 19-year-old foster daughter attempted to rescue a 9-year-old child who had been overcome by the gases present in a pit silo. This incident, which was given considerable newspaper publicity, has caused renewed interest in a subject that is periodically placed in the foreground of public attention due to similar accidents.

This case was thoroughly investigated by the USDA Bureau of Chemistry and Soils, and preliminary statements were issued almost immediately by a press release and a radio broadcast. Following this publicity numerous requests were received for further information on the prevention of silo gas accidents. This paper will summarize the findings of the Bureau, suggest safe means for removing and resuscitating persons overcome in silos, and recommend procedure for preventing such accidents.

After corn-canning operations, the farmers in this section of Maryland buy the cannery waste, consisting of portions of ears and husks, for ensiling.

About 9:30 p. m. on September 2, a load of this waste reached the farm and was left on the truck overnight, where it was exposed to a constant rainfall, and was placed in the silo about 7:00 a. m. the next morning. The packing and stamping operations were completed about 8:00 a. m. Apparently no one had been in the silo until the child entered about 3:00 p. m., when the accident occurred.

Another load was placed in the silo about 7:00 p. m. on the same evening, about three or four hours after the accident.

The authors reached the farm shortly after 11:00 o'clock on the morning following the accident.

Dr. Price entered the silo, by means of a ladder, about 11:30 a. m. and a second time about an hour later, and did not feel any distress or experience any difficulty in breathing. This was approximately 16 hours after the last load had been placed in the silo. The accident occurred about seven hours after the previous load had been stored. No information could be secured as to the history of these two loads, but it is believed that active fermentation had been in progress in the load stored at 7:00 a. m., before the accident, as compared with the last load.

It was intended to collect samples of the silo gas, presuming that conditions would be similar to what they were at the time of the occurrence. These conditions, however, were changed due to the load of material that had been placed in the silo in the evening after the accident, and the analysis of gas samples taken in all probability do not represent conditions at the time of the accident. They do indicate, however, the depletion of oxygen and increase of carbon dioxide in actively fermenting corn cannery waste.

Since carbon dioxide gas is heavier than the usual mixture of gases in the atmosphere, it forms a blanket immediately over the fermenting mass. It is necessary to disperse the heavy blanket of suffocating gas by circulation of the air above it before it is safe to enter the silo.

ANALYSIS OF GAS SAMPLES

A	Sample taken at the surface of the ensilage:			
	(1)	O_2 —	18.4 per cent	
		CO_2 —	10.2 per cent	
		N_2 —	71.4 per cent	100.00 per cent
	(2) Duplicate	O_2 —	18.1 per cent	
		CO_2 —	10.5 per cent	
		N_2 —	71.4 per cent	100.00 per cent
B	Sample taken 2 ft below surface of the ensilage:			
	(1)	O_2 —	1.5 per cent	
		CO_2 —	92.0 per cent	
		N_2 —	6.5 per cent	100.00 per cent
	(2) Duplicate	O_2 —	1.2 per cent	
		CO_2 —	91.3 per cent	
		N_2 —	7.5 per cent	100.00 per cent

Records of Previous Similar Cases. Although records of this type of occurrence are incomplete, it may be of interest to call attention to the following reported cases:

1 A North Dakota farmer was overcome while attempting to clean the pit of his silo. Four of his children also were suffocated in trying to rescue him. All five died. One other man was overcome but was rescued.

2 Two farmers in Ohio were suffocated when they entered a partially filled silo in the morning to resume the work of filling the silo and tramping the ensilage commenced the day before. An official of the Ohio Agricultural Experiment Station stated: "The men were undoubtedly killed by carbon dioxide, or carbonic acid gas, as it is sometimes called, which had accumulated over night."

3 Two men were asphyxiated in a steel bin at a grain company plant in Chicago, as the result of entering a bin filled with damp kafir corn.

4 A workman was asphyxiated at a grain handling plant in Utah when he entered a concrete bin which was filled to within 7 ft of the top with damp barley. He was pulled out with a hook within 15 min, but it was impossible to revive him. The barley contained 16 per cent moisture, with a temperature of 70 F, and had been in the bin 68 days. An analysis of the air showed O_2, 3.48 per cent; CO_2, 12.65 per cent, and N_2, 83.87 per cent.

5 Two employees of a grain elevator company in Illinois were asphyxiated in a 12x12-ft tile bin which was about half full of damp oats. The plant was drying oats, and as the grain did not run freely, one of the men went into the bin to open up the choke. He was overcome, and another workman, realizing that an accident had befallen his fellow workman, called the superintendent, tied a rope around himself, and went to his rescue. Both men were overcome, and although their bodies were shortly removed by the firemen's rescue squad, they could not be revived.

HOW TO PREVENT SILO GAS ACCIDENTS

1 Because of the presence of suffocating gas, care should be exercised on entering silos during the storage of fresh material for ensiling.

2 The greatest danger comes when large quantities of carbon dioxide gas are generated during the fermentation that always takes place. *(Continued on page 106)*

Presented before the Farm Structures Division of the American Society of Agricultural Engineers, at Chicago, Ill., December, 1936.

Author: Respectively, principal engineer in charge, senior engineer (Mem. ASAE), and assistant engineer, chemical engineering research division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Lightning Protection of Farm Buildings

By W. L. Lloyd, Jr.

KNOWLEDGE of lightning, its nature and characteristics, has advanced to such an extent that practical immunity from damage by lightning can be provided today for any structure regardless of its size, location, or construction.

In Iowa, a careful estimate indicates that about one-half of the farm buildings are equipped with lightning rods. In the six-year period from 1919 to 1924, 874 nonrodded buildings in Iowa, with a total loss of $1,953,850, were destroyed by lightning according to the annual reports of the state fire marshal. During this same period but 50 rodded buildings with a total loss of $143,226 were destroyed by lightning, and many, if not all, of these were improperly equipped with rods. One church with a loss of $20,000 had rods which had been installed in about the year 1890. Any building on which an installation of rods has been made is necessarily recorded as a rodded building regardless of the nature or condition of the installation. About one-third of the so-called rodded barns were found to have had defective rods. Although the number of rodded and nonrodded buildings are believed to have been equal, about 18 times as many nonrodded as rodded buildings were destroyed by lightning during the six-year period. From 1926 to 1930 the ratio was 29 nonrodded buildings destroyed by lightning for every rodded building destroyed.

The National Board of Fire Underwriters reported that of 38,266 farm fires in 1918, 19,820, or 51 per cent, were due to lightning. All of these lightning fires occurred in nonrodded farm buildings.

The same board charged lightning with a total reported insurance loss in the United States of $12,353,222 during the year 1921. More recently the losses have averaged over $16,000,000 per year. Unreported insurance losses in mutual companies would increase these losses by 25 per cent, according to the report of the board from which these figures were taken. In addition there are the losses not covered by insurance and the so-called indirect losses. The U. S. Bureau of Standards states that the total lightning loss amounts to double the above values in the United States each year.

The U. S. Department of Agriculture recommends the protection of all important farm buildings where thunder storms are frequent and intense, particularly where human or valuable animal life is involved. Throughout the larger portion of the United States, lightning constitutes a real hazard to both life and property. Practically all of this hazard and the enormous resulting loss could be eliminated by lightning protection. For the average structure or dwelling, there is little doubt of the effectiveness of a lightning rod system when properly installed, or of its value on any exposed structure outside of certain areas on the Pacific Coast, where lightning is of infrequent occurrence.

A lightning rod system practically eliminates the chance of damage but does not prevent a stroke. Some slight discharge may occur from the points preceding a discharge from the cloud, and it has been suggested that this tends to prevent a stroke. The effect, however, is small and not the main function of the rods. A structure is provided with a lightning rod system to prevent damage, not to prevent strokes.

On the other hand, lightning rods do not *draw* lightning. Even if they did, no harm would be done, provided the rods were properly installed. It can readily be seen that a rod projecting, at most, but a few feet above the structure, can have but little effect in drawing the stroke to a given house from a cloud perhaps a thousand feet high. Lightning can be controlled, but not so readily controlled as

Presented before the North Atlantic Section of the American Society of Agricultural Engineers at Skytop, Pa., October 1936.

Author: Engineer, High Voltage Engineering Laboratory, General Electric Company.

LIGHTNING IN OKLAHOMA

LIGHTNING OBSERVATORY OF THE GENERAL ELECTRIC COMPANY AT PITTSFIELD, MASS.

that. If the rod were removed, the stroke would undoubtedly strike within a few feet of where the rod had been.

A flag pole, mast, church steeple or house should not be more frequently struck if made of, or covered with metal, than if made of wood. This is because wood, especially when dirty, wet or damp from exposure outdoors, is sufficiently conducting to maintain its uppermost surface at ground potential fully as well as metal before the cloud discharges. Upon being struck, however, their performance is different. In the case of wood the lightning bolt suddenly finds that the path to ground is a high-resistance one through which the enormous current of the stroke can not readily flow. A high voltage appears across the wooden object subjecting it to side-flashing to an adjacent object, to splitting, shattering, firing or disruption. On the other hand, a metal object, if of sufficient cross-sectional area and grounded, readily conducts the high discharge currents to earth and no damage is done.

The main function of the lightning rod system is then apparent. The rod system makes the structure perform entirely like a metal structure by receiving the stroke and discharging it harmlessly to conducting earth. Dangerously high induced voltages within a structure are also prevented by proper interconnection and grounding of metal parts.

A properly designed and installed lightning rod system comprises the following:

1 A sufficient number of conducting points (called air terminals) so located about the upper parts of the structure to be protected that all parts likely to receive and to be damaged by a stroke of lightning are prevented from receiving the stroke which contacts, instead, one or more of these points. The number and the location of the air terminals are important.

2 A network of conductors interconnecting the air terminals to conduct the discharge over the roof and down the side walls of the structure to the ground connection. The size of the conductor, the method of interconnecting the points, and the number and location of the down conductors are important.

3 A system of ground connections to conduct the enormous current of the stroke harmlessly to ground. Because of the magnitude of the current involved, the nature of the ground connection at the lower end of each down conductor, with particular reference to the character of the soil being contacted, is important.

4 A system of conductors interconnecting or grounding, or both interconnecting and grounding all extensive bodies of metal within or about the structure to be protected. Interconnection of the metal parts is for the purpose of preventing sparks between these objects which would endanger life or property. Grounding of the metal parts is for the purpose of preventing dangerous rises in voltage above ground. The interconnecting and grounding of the metal objects depends upon the size and location of these objects with respect to the system and ground.

Since the current which flows through the lightning rod system in the event of a stroke is of the order of 100,000 amperes, while the current which flows in the ground connection of the radio antenna during normal reception is measured in millionths of an ampere, the ratio of currents between the two is one hundred billion to one and may occasionally be as high as several hundred billion to one. This gives an idea of the importance of adequate ground connections for lightning rod systems, and the extreme care which must often be taken to secure lightning rod grounds in localities where little or no difficulty is experienced in securing suitable ground for a radio receiving set.

The advantages of the properly designed and installed lightning rod system, therefore, are that the stroke of lightning which would otherwise strike and do damage to the property is received on the air terminal above the property, conducted harmlessly downward to ground and there discharged to earth without damage. Dangerous voltages between metal objects and to ground within the building are prevented and the occupants of the building are often not aware that the building has been struck.

It is a fact that lightning rods afford protection and that today they can be properly installed. Statistics and research indicate that the place of greatest safety during lightning storms is in an all metal or well-rodded building.

Prevention of Silo Gas Accidents

(Continued from page 104)

This fermentation, which begins immediately, may continue for several days.

3 Increase in carbon dioxide, together with the actual lowering of the oxygen content of the air, often results in a mixture of gases that will not support life, and persons entering the silo are in danger of suffocation.

4 The pit silo, with its lack of ventilation, is the source of greatest danger from gas suffocation.

5 Air in above-ground silos may be regulated by keeping one of the many doors open near the surface of the silage. Care should be taken to open the doors as near the silage level as possible, after it has had time to settle.

6 The presence of dangerous gases may be detected easily by lowering a small animal or fowl, or a miner's safety lamp if available, into the silo before anyone enters. If the atmosphere is dangerous, the animal or fowl will be affected, but may be revived when brought back into fresh air. The lamp will be extinguished.

7 No attempt should be made to enter the silo until the gases have been removed by agitating the air with a blanket, a piece of canvas, a basket on a rope, the limb of a tree, or similar devices to circulate the air, or by proper ventilation. Circulation of the air also may be obtained by operating the ensilage-cutter empty for several minutes. The discharge pipe should be extended down almost to the surface of the material.

8 No one should enter the silo while the fermentation is in progress, unless others are present to render necessary aid in case of an accident.

9 When it is necessary to rescue a person overcome by gas in a silo, a rope should be tied securely to the person entering so that he can be removed promptly. If possible, the air should be agitated quickly before he enters.

10 In cases of suffocation from silo gases, the person affected should be removed as quickly as possible and artificial respiration given immediately, if he has stopped breathing. The person is suffering from lack of oxygen and the artificial respiration permits fresh air to enter the lungs.

11 The U. S. Public Health Service recommends the prone pressure method. In this method the victim is placed face downward with his nose and mouth to the air by turning the head to one side. The bad air is forced out of the lungs by the operator alternately applying and releasing pressure on the back, above the level of the lower rib.

Measuring Equipment Used in Watershed and Hydrologic Studies

By W. D. Ellison

THE watershed and hydrologic studies project of the USDA Soil Conservation Service was established at Coshocton, Ohio, In November 1935. Since that date, engineers (agricultural and hydraulic), soil scientists, foresters, geologists, and meteorologists have been studying the watersheds of this area, planning a program of research, and designing and installing equipment for scientific studies. This project embraces a study of the hydrologic cycle on two series of watersheds with each series including areas of various sizes. One series is to be maintained under farming practices prevailing in this region, and the second series is to be improved by introducing good land-use and erosion-control practices.

Hereinafter the term "correct conservation farming practices" will be used, implying the best known land-use and erosion-control practices. The term "infiltration" is used as defining the process by which water enters the zone of aeration; and "percolation" refers to the movement of ground water in stream-line flow in any direction through small interconnected and saturated interstices of rock or earth.

At the Upstream Engineering Conference held in Washington, D. C., September 22 and 23, 1936, many of the speakers made special mention of the lack of hydrologic data that show the magnitude of factors in the hydrologic cycle and the magnitude of influence on any or all of these factors that may result from a decided change in land-use and erosion-control practices.

Thorndike Saville in his paper entitled "Basic Principles of Water Behavior," makes the following introductory comments: "Rational exposition of the behavior of water as it occurs in the atmosphere, on the surface of the ground, and underground, is the science of hydrology. Although man has for thousands of years been more directly affected in his life and developing civilization by water than by any other manifestation of nature, and although there is an enormous amount of literature on the subject, it is not yet possible to call hydrology a science in the sense that, given definite factual premises, such as rainfall, one cannot accurately deduce the resulting disposition of the water in a scientific and mathematical manner. This is due to two chief factors: (1) the great complexity of the hydrologic cycle, and (2) the lack of adequate observational data, which when correlated will permit accurate scientific deductions."

Some of the questions that our leading hydrologists and conservationists would have answered are:

1 In what way do the factors of intensity and duration of rainfall combine with the influence of watershed characteristics, such as vegetative cover, size, shape, slope, soil, symmetry, and channel pattern, to affect surface runoff?

2 Can the concentration of flood waters be appreciably retarded and the flood crests lowered by correct conservation farming practices?

3 What is the relation of both quantity and character of soil losses on small to large watersheds, and what is the influence of correct conservation farming practices on these losses?

4 What per cent of the rainfall is lost as surface runoff on small to large watersheds when they are farmed according to average farming practices now prevailing, and what are the losses when correct conservation farming practices are followed?

5 How effective are correct conservation farming practices in conserving storm waters for the use of crops during periods of light rainfall?

6 To what extent do correct conservation farming practices influence rates and quantities of (a) infiltration, (b) percolation? And do they tend to raise the ground water level?

7 Do some crops tend to maintain a higher ground water level than others?

8 What effect do correct conservation farming practices have on quantities of water released from a watershed to the atmosphere?

9 What is the effect of correct conservation farming practices on the accumulation and the rate of melting of the snow blanket, and what is the effect of the snow cover on the physical state of the underlying soil?

To study some of the problems presented by these questions, more than 80 watersheds, varying in size from 1 to 5,000 acres and varying in shape, cover, topography, soils, aspect, symmetry, extent of erosion, and in their drainage pattern, have been partially classified and grouped into series. All watersheds in each series are similar and they will be calibrated under similar conditions of cover in an effort to evaluate the inherent physical differences which influence the runoff. It is thought that the calibration period will require 3 to 5 years; the more nearly comparable all the

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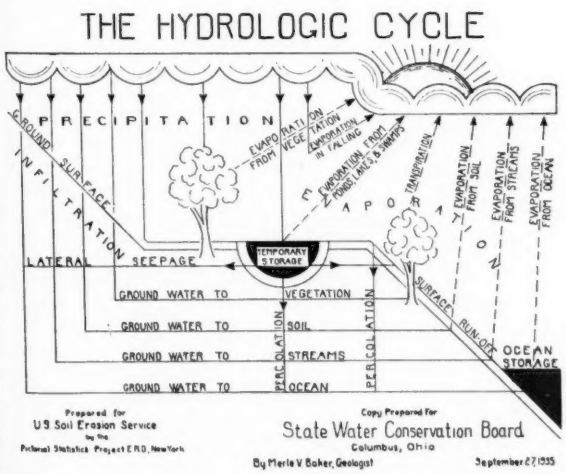
Presented before the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1936.

Author: Hydraulic engineer, Soil Conservation Service, U. S. Department of Agriculture, Assoc. Mem. ASAE.



FACTORS BEING STUDIED IN THE COSHOCTON PROJECT

(LEFT) SECOND-ORDER METEOROLOGICAL STATION PARTIALLY COMPLETED. (RIGHT) COLUMBUS TYPE OF DEEP-NOTCH CONTROL WEIR

natural characteristics of each watershed series, the shorter the period of calibration required.

To complete the measure of hydrologic factors and related events which have a bearing on the water cycle, many and various types of instruments are required. In selecting equipment for this work, standard instruments used by various research workers in the past were first studied and those that met our requirements were selected. Where these designs did not meet our requirements of accuracy and adaptability, new designs are being made.

One first-order meteorological station, 15 second-order stations, and approximately 125 third-order stations are to be established. The first-order station will be equipped with one 8-in USDA Weather Bureau standard rain gage; one 8-in weighing and recording rain gage; one Weather Bureau standard evaporation pan, one Colorado land pan, one anemograph, one sunshine duration transmitter, one anemometer, one atmometer, one barograph, one hygrothermograph, one standard mercurial barometer, one sling psychrometer, one hail gage, one set of maximum and minimum thermometers, one soil thermograph, and one snow board.

The second-order stations are equipped with one 8-in Weather Bureau standard rain gage, one 8-in weighing and recording rain gage, one set of maximum and minimum thermometers, and one snow board.

The third-order weather bureau stations will have only an 8-in Weather Bureau standard rain gage and one snow board.

In wooded areas some of the second and third-order stations will also be equipped with hygrothermographs, and a complete set of the instruments will be set both above and below the tree canopy. Towers are being constructed for mountings above tree canopies, and by reading the two sets of instruments simultaneously we can determine the influences of the tree canopy on interception of rainfall, temperatures, humidity, and evaporation opportunity.

The 8-in Weather Bureau standard rain gage is an old and familiar piece of equipment. The top or intercepting section is provided with a funnel-shaped bottom that conducts rainfall into the receiver which is a tall cylindrical measuring tube. This tube has a cross-sectional area of only one-tenth of that of the intercepting area and this area reduction makes for accuracy in the rainfall readings.

The weighing and recording gages have an interception area of 8 in, a capacity of 9 in of rainfall, and are equipped with 12-hr, clock-driven charts. This large time scale, together with the fact that the pens on these instruments reverse directly at increments of 3 in of rainfall, permits an exceedingly open record. The funnels in these instruments may be removed during the winter, thus making the instrument effective as a recording snow gage. Since this weighing mechanism gives a continuous record of weight in terms of inches of water with respect to time, water-equivalent determinations are unnecessary. Several experimental rain gage installations will be used for the purpose of determining the effects of wind velocity, elevation above ground surface, type of shielding, etc., on the catch of rainfall.

The standard Weather Bureau Class A evaporation pan is a circular pan 4 ft in diameter and 10 in deep, made of galvanized iron and is installed above the ground surface. The Colorado land pan is square, 3 ft on an edge, 18 in to 3 ft deep, and is buried in the soil with the top 4 in above the ground surface. The water elevation is maintained flush with the surface of the soil.

The sunshine duration transmitter records on the anemograph chart by means of electrical impulses. As may be seen from the view showing the glass portion of the instrument, the upper chamber is narrowed into a slender tube which extends almost to the bottom of the lower chamber. The lower bulb is coated with lampblack, hence, when the sunshine falls upon the instrument, the air in the lower bulb will become warmer than the air in the upper glass bulb, and the consequent expansion of the air in the lower bulb exerted against the surface of the mercury in the slender connecting tube causes a corresponding rise of the mercury in the tubing. When the mercury reaches the inner ends of the platinum wires located in the center of the narrow tube, an electric circuit is closed which actuates a pen mounted on the anemograph recorder drum. When the mercury recedes in the inner tube the circuit is opened, causing pen movement on the recorder. The time elapsing between the make and break of this circuit is the time of sunshine duration.

The anemograph is a comparatively new development embodying the old principle of the Pitot tube. This instrument will be installed above the roof of a large instrument shelter at the first-order meteorological station, with the recorder mechanism located in the room below where it will record continuously the wind velocity and direction.

A three-cup type anemometer will register the total wind movement over the evaporation pans.

A Livingston type atmometer will be installed to supplement the record of evaporation pans which give a relative measure of evaporation opportunity.

The barograph is installed for the purpose of obtaining a continuous record of atmospheric pressure. This instru-

ment will be checked from time to time with a standard Weather Bureau mercurial barometer.

The hygrothermograph makes possible a continuous record of relative humidity and dry bulb temperature on a single chart, thus making possible the rapid calculation of various psychrometric factors affecting evaporation and transpiration. The hygrothermograph element of this instrument is checked periodically by means of a sling psychrometer.

A hail gage is merely a rain and snow gage which has a large intercepting area and a deep receptacle to intercept the hailfall. The intercepting area is increased because of the impracticability of splitting all hail stones on the edges of the intercepting rim. It is thought that an interception area somewhat larger than is provided by the 8-in rain gage is needed to obtain a representative sample of the hailfall. The depth is increased to prevent loss by rebound of the hail stones.

The soil thermograph will be used to obtain continuous records of soil temperatures. Periodic soil temperature measurements will also be made throughout the experimental area by means of thermocouples permanently located at varying soil depths, under different soil covers and on areas representative of different degrees of erosion.

The snow boards we are using are 12x12 in, made of white pine, and shellacked and covered with muslin to prevent air currents from removing the snow from the surface. This muslin also serves to reduce melting as the result of radiation of heat from the shellacked surface of the board.

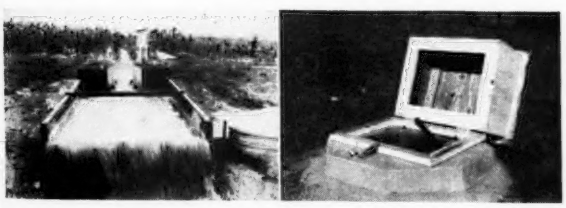
In addition to these installations at the meteorological stations we will have several atmometers, anemometers, and perhaps other instruments located at points where intensive study is to be made, and at some points quite remote from the first order station.

Snow sampling tubes will be used to supplement the snow board observations. These tube measurements will be made on designated circuits representative of the hill and valley lands of the watersheds.

The snow sampling tubes we intend to use consist of a seamless aluminum tube built in sections. They are 1¾ in outside diameter and with a milled cutter on one end. The tube is rotated as it is forced vertically into the snow, and the sample core is brought up in the sampler as it is lifted vertically out of the snow blanket.

Small openings in the tube permit reading inches of snow, and a specially constructed scale is used for weighing to determine the water equivalent of the snow sample. This conversion factor is then used in converting inches of snow on the snow boards to inches of water.

Surface runoff will be measured from areas having a maximum discharge of more than about 1,000 cfs (cubic feet per second), by using the Columbus type deep-notch control weirs at the sections to be rated by current meter measurements. With these installations, a concrete shelter well houses a continuous type water-stage recorder. This recorder provides a record of head on the weir at all times. On our charts each 24-hr period is represented by 28.8 in of paper travel and each foot of stage-difference in the stream is represented by 5 in of pen movement on the chart. This exceedingly open record of time and water stage permits an accurate computation of the time of concentration for the watershed.



(LEFT) PARSHALL FLUME AND RAMSER SILT SAMPLER INSTALLATION. (RIGHT) TOP OF GROUND WATER OBSERVATION WELL

A cableway or footbridge is provided for use in making current meter measurements at those stations where highway bridges are not available. All cables are equipped with gaging cars from which the meters are suspended.

Silt samples will be taken at these stations intermittently, during the time of gaging, by use of one or more types of silt samplers. We are now using the Savage, the Tait-Binckley and intend to use the Eakin biscuit type sampler. We expect to use others as the work progresses.

Parshall flumes will be used on watersheds having a maximum discharge of approximately 30 to 1,000 cfs and silt samples will be taken on these areas in the same way as those at the Columbus type control weirs. Low flow, of less than about 15 cfs will be measured by a small weir or flume, installed in parallel with the larger structure. The arrangement will be such that flow of less than about 15 cfs will all pass through the small structure.

On areas where total maximum runoff does not exceed the capacity of a 2-ft Parshall flume, standard Parshall flume and Ramser silt sampler installations will be made. These units consist of a Parshall measuring flume; a silt box placed immediately below the flume, which intercepts a large portion of the material carried by the stream; a suppressed rectangular weir which is placed 2 in below the level of the outlet of the Parshall flume; a sampling slot ½ in wide and 8 in high, which intercepts a portion of the runoff. The bottom of this slot is placed level with the crest of the suppressed weir and 2 ft upstream. The sample caught by this slot passes into a divisor box which wastes six-sevenths of the total sample and passes one-seventh of it into a sample storage tank. The sampling tank yields a sample which may be analyzed to determine the silt content of the water passing over the weir at the lower end of the silt box. A small shelter is built at one side of the Parshall flume, and a water stage recorder provides a continuous curve of the depth of flow, a function of the total runoff.

Many of our channel grades approaching flume sites are very steep, and the velocity of approach is greater than critical velocity in the flume. In many instances this high velocity is of such magnitude as to preclude the use of the Parshall flume. The California Institute of Technology, the hydraulic laboratory at the University of Iowa, and the National Hydraulic Laboratory are now working on the development of flumes that may eventually overcome these troubles. In the meantime, we are attempting to adapt some of the flumes now in use to fill our special needs. In this we are giving careful attention to approach sections which will dissipate high velocities of approach without causing large debris deposits at the flume entrance.

Our watercycle lysimeters are of the in-situ type, of two milacre area and constructed in batteries of three units each. They are so equipped as to collect surface runoff and convey it to a tank where rate and quantity of surface drainage are recorded. The tanks are 8 ft deep, and the percolate falls into metal pans with perforated tops. These perforations are ½-in holes on 2-in centers. The perforated tops of these pans serve as a bottom or floor section of each lysimeter tank. From these pans the percolate is conveyed

through pipes to collector tanks where quantity of percolation is recorded with respect to time.

The watercycle lysimeter used at Coshocton is perhaps unique in several respects. It is unusually large for in-situ construction. Four steel strips are used on the inside of each tank wall, and these have a "piston ring" effect in cutting off flow through cracks that may develop between the soil and the walls of the tank when the soil is very dry. The tank top conforms to the slope of the adjacent soil surface and it is provided with a means of complete surface drainage. The percolate collector at the bottom of each structure is divided into eight equal sections so that the water passing through eight separate soil columns can be isolated. Trough rain gages are set on top of each side wall of the tank for catching a large rainfall sample.

The procedure in construction was to build the walls of the tank above the surface, then dig the tunnel, construct the supporting walls for the pans, and jack the pans into place on their supporting walls while the concrete in the walls of the tank was curing. The tank was then lowered onto the pans and sealed to them, using tar covered with concrete as a sealing material.

We are now working on the installation of a scale that will weigh one of these tanks. The total weight of a tank filled with soil is approximately 120,000 lb, and by counterweighting 100,000 lb, we intend to weigh to the nearest 5 lb, and perhaps less than the equivalent of 0.01 in of water over the tank surface. This scale will indicate the relative moisture content of the soil at all times, and by changing the land use and tillage practices from time to time, we will determine something of the influence of these changes on surface runoff, interception by plants, infiltration, percolation, evapotranspiration, and retention of soil moisture.

As a further check on soil moisture, soil samples from noneroded, slightly eroded, and severely eroded areas covered with timber, meadow, pasture, and various cultivated crops will be analyzed for moisture content.

In making soil moisture determinations gravimetrically, a soil sample of 10 to 50 grams is weighed moist and then dried at 105 to 110 C (degrees centigrade), until it reaches constant weight. These samples are obtained by forcing a steel tube of about 1¼ in inside diameter into the soil to any desired depth. The desired section of the soil core removed is then preserved in an air-tight sampling tin.

Some of our later soil moisture determinations may be made by an electric method which measures the dielectric constant of the soil as it remains in place in the field. This method would be desirable as it would permit us to sample in the lysimeters. We would not make moisture tests within the lysimeter tanks if it required removing soil cores, but if the electric method proves satisfactory it would prove to be a solution for our sampling problems in the lysimeter tanks.

We are constructing about forty ground water observation wells to study ground water fluctuations. These fluctuations may occur with seasonal changes in vegetative cover and temperatures, with alternate wet and dry periods, and with different land use, tillage and erosion-control practices. These wells are excavated to a diameter of 4 ft and are lined with dry masonry to within 4 ft of the ground surface. Above this point they are lined with concrete masonry and the top is of formed concrete. A steel peg is set in this concrete and used as a datum from which to measure water levels. Some of the more inaccessible wells will be equipped with water stage recorders, in others the water elevations will be measured daily with a steel tape, or as often as is required to plot an accurate curve of ground water changes.

Wells were located at points thought to be representative of geologic conditions throughout the experimental area. They vary in depth from 25 to 60 ft, the deeper wells being at higher levels. We have taken care to see that none of these are near pumped wells, and we believe they are all to such depth that they will not go dry during seasons of light rainfall.

To assure a high degree of accuracy in all of our time-recording instruments, a synchronization system is being installed which will be actuated by a master clock. This is constructed in connection with a field telephone system which will be used for directing observations and measurements during storm periods.

Without some such system as this, small time errors as between the rainfall and water stage recorder clocks may equal or even exceed the period of concentration of small watersheds. If proper land-use and erosion-control measures do influence the period of concentration on a watershed, this synchronization system will enable us to detect these changes. Synchronization and exact timing will also enable us to study accurately the concentration of flow from tributary streams, as their flood crests converge with the main channels of flow and the resulting crests travel toward the final outlets of the largest watershed.

Complete instrumentation of small watersheds will enable us to isolate and study the influences of watershed characteristics such as vegetative cover, aspect, soil, size, shape, slope, symmetry, degree of erosion, and drainage pattern on the hydrologic factors making up the complete water cycle. Carried on as a part of these studies will be the comparisons made to evaluate the influences of correct land-use practices of hydrologic factors. This study to evaluate by comparison of different farming practices will be embraced in each watershed series, and will continue for the duration of the project.

Most small watersheds are each an integral part of larger experimental areas. This plan makes each observation station on the small and intermediate areas serve as a part of the instrumentation pattern on the largest area, and makes possible a thorough and continuous study of all phases of the water cycle as the water moves from the upper rim of the smallest watershed down past the last observation point on the largest drainage area.

Applying Metal Coatings

MOST of us are at least vaguely familiar with two methods of applying metal coatings; electro-plating and dipping. Most of us are not familiar with a third method explained some months ago by E. L. Mathy in METAL PROGRESS. This is a metal spraying, in which globules of molten metal are sprayed on a surface in much the same manner as applying paint with a spray gun.

In the metal spray gun, drawn wire is fed into a small area of intense flame at a speed just sufficient to replace the wire as it is melted. An air driven turbine, built into the gun, actuates a simple geared mechanism which grips the wire firmly and pushes it into the flame at the proper speed. An air blast discharges the minute globules from the gun at a high velocity and they adhere to the surface being sprayed.

Any metal that can be drawn into wire can be used for metal spraying. This includes stainless steel, and Monel metal.—*Science Digest.*

Tests of Tillage Tools

I. Equipment and Procedure for Moldboard Plows

By I. F. Reed

STUDIES of tillage equipment[1] being conducted by the USDA Bureau of Agricultural Engineering at Auburn, Alabama, have as their objectives the finding of information that will aid in more efficient use of available tillage tools or that will give a basis for the design and development of new equipment to do the necessary tillage jobs most economically. This work is divided into two phases of studies, namely, field and laboratory. Indications noted in the field are studied in the laboratory and the findings of the laboratory must be checked in the field. This discussion deals only with the laboratory phase of these studies.

The USDA farm tillage machinery laboratory[2], with its equipment and eleven especially selected soils, gives for the first time a chance to study with full scale tillage tools and soils under controlled conditions, the effects of design, methods of operation, and soil physical condition upon the action, reaction, and work done by tillage tools. Numerous studies of the draft and operation of plows and other tillage tools have been made, but it has been impossible to duplicate results consistently as soil conditions were not under control; hence they could not be duplicated. This accounts in large part for the inconsistent and often contradictory results reported by other investigators. The facilities of this laboratory make it possible to produce a desired soil physical condition throughout a plot, and to duplicate this condition when desired. The question is often asked, Are the soils in the same condition as they would be in the field? Field studies in connection with this project show that actual field conditions for a soil are quite variable even though the area may be uniform. Therefore, "field condition" may be almost anything. However, a condition produced in a plot soil is not only representative of a "field condition," but has the advantage that the condition is uniform throughout. In the studies at this laboratory, the plot soils will be considered primarily as materials, varying in physical, chemical, and mechanical make-up. The reactions of these soils will be measured under a number of physical conditions. This will make it possible to predict the reactions of soils having intermediate characteristics in their surface horizons.

Classifying the soils as materials rather than by type name will give the data obtained a wider application, as type names are based on geological formation, location, weathering, and many other factors which do not influence their tillage characteristics. Thus for the application of information to be obtained from these studies, interpolation of the reactions for a soil will be made with reference to its analysis to the depth of tillage, rather than by type name. From this method of classification the laboratory soils cover the range of surface soils from sands to heavy clays in both the highly weathered and relatively unweathered soils. Thus, this limited group of soils is representative of most of the surface soils found in the southeastern states, and, except for the higher organic content in northern soils, is representative of most of the surface soils of the whole United States.

Factors favorable to the work at the laboratory, besides having a concentration of soil types, are (1) soil-fitting and test equipment operate on rails mounted on the walls separating the plots, thus leaving no wheel marks in which the soils are packed more than for other areas; (2) the soils for test are finished to a definite level surface; (3) the test equipment operates from a definite plane, rather than from an uneven surface as found in fields, and (4) equipment, soils, and trained personnel are concentrated at one point.

Methods and Equipment. The equipment available for the job of fitting the soils (Figs. 1 and 2), consists of a grader blade, subsoiling unit, disk unit, subsurface packer, smooth surface roller, and a sprinkling unit, all of which can be mounted on a car in place of the roller, except the sprinkler unit which mounts on the front of the car (Fig. 3).

The present method of fitting plots includes the following five to seven operations, depending upon the condition of the soil as left by the preceding test:

1 If the soil worked up by test operations contains

Presented before the Power and Machinery Division at the winter meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 1936.

Author: Assistant agricultural engineer, USDA Bureau of Agricultural Engineering. Jun. Mem. ASAE.

[1]These studies are being conducted cooperatively with the Alabama Agricultural Experiment Station.

[2]Randolph, J. W. and Reed, I. F. The Farm Tillage Machinery Laboratory. AGRICULTURAL ENGINEERING, vol. 16, no. 6, June 1935, pages 219-220.

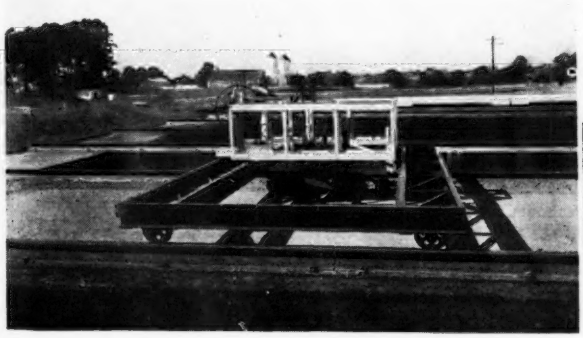
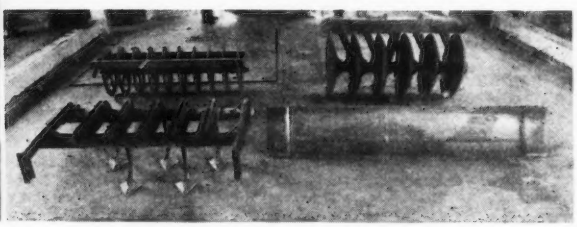


FIG. 1 (LEFT) SOIL FITTING UNIT WITH FLAT ROLLER MOUNTED ON THE GRADER CIRCLE. THE FRAME CARRYING THE GRADER CONTROLS IS MOUNTED ON ROLLERS SO THAT THE FITTING TOOLS CAN BE MOVED CROSSWISE ON THE PLOT. FIG. 2 (BELOW) GRADER BLADE, SUBSOILER, SUBSURFACE PACKER, AND DISK UNIT, WHICH CAN BE MOUNTED ON THE CIRCLE OF THE UNIT SHOWN IN FIG. 1



large lumps, they are broken up by use of leveling blade or disk unit, or both, as required. If no firm lumps are present, this operation can be omitted.

2 The plot is subsoiled to at least 2 in below the depth of the tests to follow. This operation prevents the formation of a plow sole or of line of demarkation between the soil that was worked by previous test and the soil below.

3 After subsoiling, the plot is leveled with the blade unit.

4 The plot is then rolled to the desired apparent specific gravity. Only the flat roller shown (Fig. 1) is being used at the present time, though it does not produce exactly the soil condition desired. The subsurface packer shown has been tried, but has not proven satisfactory as yet, due to the cleavage lines produced in the soil by the packer wheels.

5 Water is applied to the soil with the sprinkler unit (Fig. 3) to bring it up to the desired moisture content. The water may be applied at any step during the fitting process, or after the soil has been rolled. A careful study of each soil under a number of conditions will determine the correct time of sprinkling to produce a desired physical condition.

6 The final operation, usually made just before the tests are run, is to shave the plot to as nearly a plane surface as possible. The blade is set to cut any high points to the level of the lower areas and not leave any loose soil on the surface of the plot in the area to be used for tests.

7 The cover cars (Fig. 4) may be placed over any plot whenever it is necessary to prevent weather conditions causing changes in the physical conditions of the soil. They serve equally well for preventing the soil from drying out or being wet by rain.

Test Equipment. The test equipment consists essentially of two major units—the power car with the special dynamometer and the plow test unit (Fig. 5). The power car unit furnishes the motive power and measures and records the components of draft necessary to handle the job. The plow test unit measures and records the forces necessary to hold the rear of the plow in its working position.

Partial specifications for the power car and dynamometer were given in a former article[3]. However, it was not explained that the dynamometer was mounted on a superframe that can be moved crosswise of the power car,

[3]Nichols, M. L. and Reed, I. F. Soil Dynamics: VI. Physical Reactions of Soils and Moldboard Surfaces. AGRICULTURAL ENGINEERING, vol. 15, no. 6, June 1934.

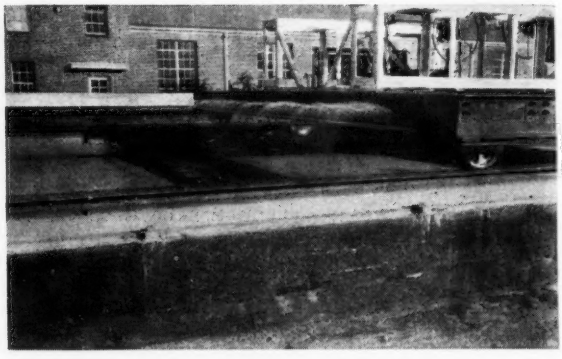
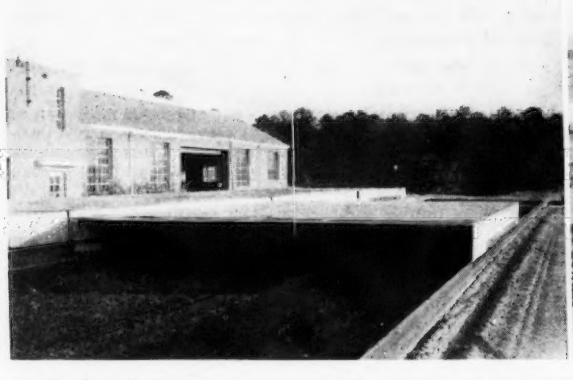


FIG. 3 THE SPRINKLER UNIT CONSISTS ESSENTIALLY OF A 1-IN PIPE MOUNTED ON THE FRONT OF THE SOIL FITTING CAR. THE ORIFICES ARE 1/16 IN IN DIAMETER AND SPACED 1 IN APART

or that the dynamometer can be moved vertically approximately 40 in in the drawbar heads of this superframe. These adjustments enable locating the hitch point of the dynamometer at about any desired position relative to the plow bottom or other tool being tested. The three components of draft are recorded on the same chart with distance and time, thus making it possible to check the components of draft and speed for any part of any test. A representative test chart is shown in Fig. 6.

The plow test unit is mounted in a car that must be hitched rigidly to the power car. It consists of a plow beam (Fig. 7) with the front end carried on the dynamometer and the rear end mounted on two hydraulic units supported on a frame which may be moved crosswise of the plot in the framework of the car. A third hydraulic unit is located (Fig. 8) to take the horizontal force exerted on the plow bottom by the resistance of the soil to turning. The net horizontal reaction is the algebraic sum of this force and the horizontal force on the dynamometer. The algebraic sum of the loads on the two hydraulic units supporting the plow beam and the vertical component on the dynamometer, minus the weight of the plow on these units, gives the upward or downward force exerted by the bottom. This unit with the power car dynamometer enables measuring the reactions of a plow bottom as the bottom is held in its working position entirely by hydraulic units. The load on each unit is recorded continuously for a test. The hydraulic units used on the plow test unit were made by soldering



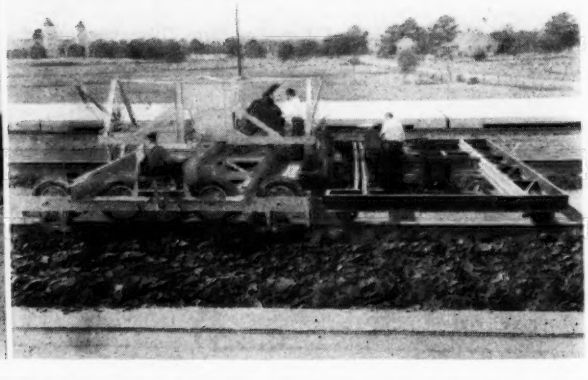


FIG. 4 (LEFT) THE COVER CARS ARE 26 FT LONG AND ARE COVERED WITH CORRUGATED SHEET METAL. THE TOP SLOPES TO AN EAVE TROUGH WHICH CONDUCTS ANY RUNOFF TO A DRAIN PIPE IN THE WALL. NOTE THE HINGED FLAP FOR COVERING THE CRACK BETWEEN CARS. FIG. 5 (RIGHT) POWER CAR AND PLOW TEST UNIT WITH CREW IN POSITION. THE SMALL WHEEL DIRECTLY UNDER THE OPERATOR'S SEAT FURNISHES IMPULSE FOR RECORDING DISTANCE ON THE CHART

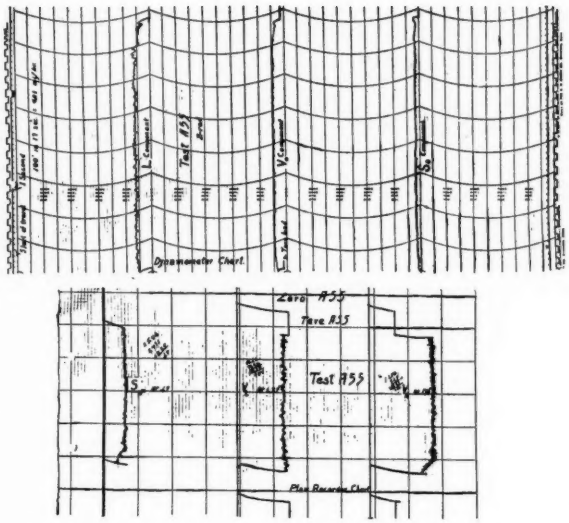


FIG. 6 TEST CHARTS FROM THE POWER CAR DYNAMOMETER AND PLOW TEST UNIT RECORDS

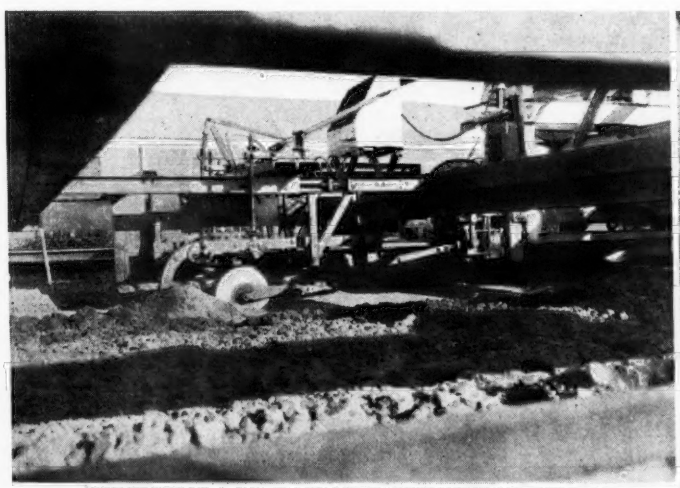
heads into regulator bellows designed to handle pressures up to 75 lb per sq in and building the leverage mechanisms for increasing the load capacities of these cells. Note that the cells supporting the plow beam are mounted in a frame designed so that loads in either direction will be measured as compression loads on the cell, and that the cell for measuring the horizontal reaction is held in alignment by use of a flexure. These arrangements give units that can be made up cheaply, and in that a number of sizes of bellows are available, units of almost any capacity can be built. This arrangement forms a closed system so there is no leakage as with a piston unit, and a unit maintains a definite length. This is of value especially when the unit is to take loads in either direction.

The pressures exerted on the hydraulic units of the plow test unit are recorded in the homemade recorder (Fig. 8). This recorder is simple to build and can be built in almost any moderately equipped machine shop. It consists of a simple adaptation of commercial helical spring pen units of suitable pressure ranges so mounted as to record on a strip type chart. The roll on which the finished chart is wound is driven through a flexible shaft from the chart drive mechanism of the power car. Since this mechanism is driven directly from the wheel drive it is possible to correlate the data on the two charts with the location in the plot. This recorder is designed for three pens, but the length can be adjusted to accommodate the number necessary. If this type of recorder is to be used on a field unit, it can be driven by a ground wheel, or, if more convenient, by a phonograph motor or other suitable means. Each spring must be calibrated for the hydraulic cell with which it is to be used. The arrangement used on the dynamometer chart of having the equivalent of ground drive and having increments of time marked on the chart gives a permanent and exact record, from which the speed for the entire or any portion of the test may be obtained. These speeds do not have to be determined at time of the test, but are calculated at the time the chart is worked up.

The plow-measuring bench and methods developed by Nichols and Kummer[4] will be used for determining the shape of plow bottoms studied. Radius of the arc and the angles through which it swings in sweeping out the mold shapes will be correlated with the plow reactions and draft.

Test Procedure. Though the plot soils are prepared for test by a predetermined series of operations designed to produce, as nearly as possible, a desired soil physical condition, three to five undisturbed core samples are taken for laboratory measurement. These samples are taken with a sampling tube approximately 15 in long and 2⅜ in in

[4]Nichols, M. L. and Kummer, T. H. The Dynamic Properties of Soil, IV. — A Method of Analysis of Plow Moldboard Design Based upon Dynamic Properties of Soil. AGRICULTURAL ENGINEERING vol. 13, no. 11, November 1932, pages 279-285.



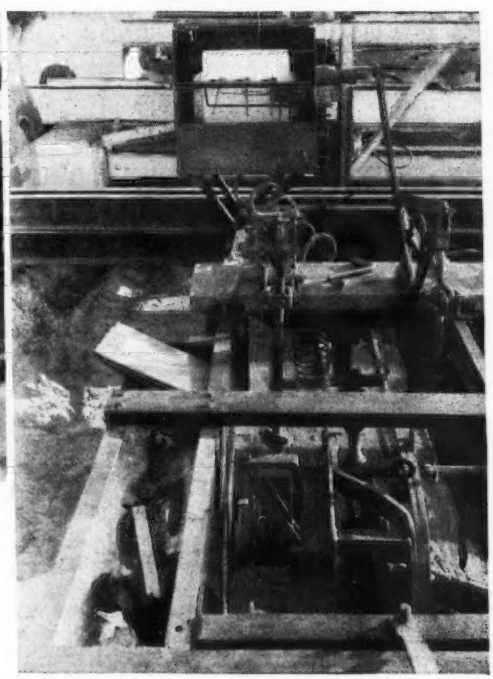


FIG. 7 (ABOVE) VIEW OF RIGHT SIDE OF PLOW TEST UNIT SHOWING V_r CELL, RECORDER, AND METHOD OF HITCHING FRONT OF PLOW TO POWER CAR DYNAMOMETER. FIG. 8 (RIGHT) TOP VIEW OF PLOW TEST UNIT SHOWING CELL FOR MEASURING HORIZONTAL PRESSURE, THE V_1 CELL AND FACE VIEW OF THE RECORDER. NOTE ALSO THE SHEAR PLANES IN THE FURROW SLICE AS DESCRIBED BY NICHOLS AND REED

diameter at the cutting edge. It is of the type shown by Reed, Baer, Condrey and Cutler[5] and Yoder[6] and is designed to give minimum compression of the sample. These cores are cut into sections exactly 2 in in length, measuring them 0 to 2 in, 2 to 4, etc., to approximately 2 in below the greatest depth at which the plot is to be plowed. The per cent water and apparent specific gravity is determined for each section or horizon of each sample. This enables calculating the physical condition of the soil to the depth to which it is to be worked and shows how this condition varies from the soil surface to the depth of the sample. This method of sampling will make it possible to determine whether reactions of a plow, for example, are primarily dependent on the soil physical condition at the cutting edge or the condition of soil to the depth of plowing.

A plot is opened for tests by excavating a trench approximately 3 ft wide across the starting end and plowing out the first furrow. The trench permits adjusting the plow bottom to its working position before starting a test.

The equipment is set for a test as follows: (1) The dynamometer is moved to the required position relative to the furrow wall and is adjusted to give the desired height of hitch point, (2) the plow test unit is moved the width of cut toward the unplowed ground and the screws supporting the beam on the hydraulic units are adjusted to the depth of cut and to level the beam crosswise, (3) the hitch setting on the front of the plow beam is adjusted to level the beam lengthwise and line the beam correctly with the direction of travel, and (4) the coulter and, or, other equipment is adjusted.

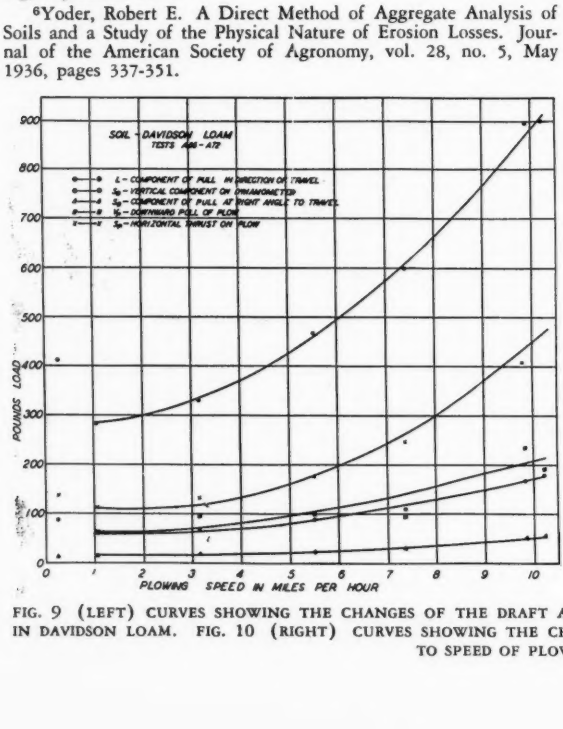
A test crew consists of three men as follows: (1) One man on the plow test unit to check all adjustments, observe operation of the plow, record hitch setting and attachments, and note approximate speed and other pertinent information; (2) one man at the dynamometer controls; and (3) one man at the power car controls. The speed of the power car is controlled by hand throttling, and it has been found to be more satisfactory than mechanical governing. By observing the tachometer and speedometer closely and handling the throttle carefully, the operator can control the speeds to within 0.05 mph (mile per hour) for the lower speeds and 0.1 mph for the higher ranges. The operator must be on his job especially at the top speeds as the time for a test, including accelerating and decelerating, may be less than 20 sec, leaving only 6 to 8 sec for the test at the desired speed. Since all loads and reactions are recorded continuously, the men at the recorders are free during actual test time to observe the operation of the plow and the recording mechanisms. Tests are numbered consecutively, and complete notes are kept of any condition or occurrences that might affect the test results.

Data Obtained. The data and curves presented in the following discussion are to show the type of information obtained in a plow test and the versatility of the equipment. The plow bottom used for the tests shown was virtually only a cutting edge and plow mold surface as the landside and any bearing areas on the under side of the share were removed. It was further altered by welding 3/8 in additional metal to the shin of both share and mold to insure that there was clearance between the furrow wall and frog. The coulter was set to cut two-thirds the depth of plowing, but was mounted on a frame separate from the plow beam so its reactions are not measured with those of the plow bottom. Thus the data shown are the reactions for the bottom shearing loose the remainder of the furrow slice and lifting and turning it. One setting of the test equipment was used for all these tests. By measurements in a number of soil conditions it will be possible to determine how the centers of reactions vary with soil factors.

Fig. 6 shows typical charts for a test. These charts are worked up by one of two methods depending upon irregularity of the pressure line. If the record is regular, a mean line can be drawn and the average value or height measured from the chart, but if irregular, a definite length of chart is laid off and the average height determined by use of a planimeter. The load values are then determined from calibration curves. Table 1 shows typical data for a series of tests. It will be noted in this table that the V_1 force is

[5]Reed, I. F., Baer, N. R., Conrey, G. W., and Cutler, J. S. Procedure for Making Draft Tests of Plows, directions for making square yard harvest of legumes, and description and use of soil sampling tube. Mimeographed, Bureau of Agricultural Engineering, September 1933.

[6]Yoder, Robert E. A Direct Method of Aggregate Analysis of Soils and a Study of the Physical Nature of Erosion Losses. Journal of the American Society of Agronomy, vol. 28, no. 5, May 1936, pages 337-351.


SOIL - DAVIDSON LOAM
TESTS A88 - A78
L - COMPONENT OF PULL IN DIRECTION OF TRAVEL
S_p - VERTICAL COMPONENT ON DYNAMOMETER
S_p - COMPONENT OF PULL AT RIGHT ANGLE TO TRAVEL
V_p - DOWNWARD PULL OF PLOW
S_p - HORIZONTAL THRUST ON PLOW
POUNDS LOAD
PLOWING SPEED IN MILES PER HOUR

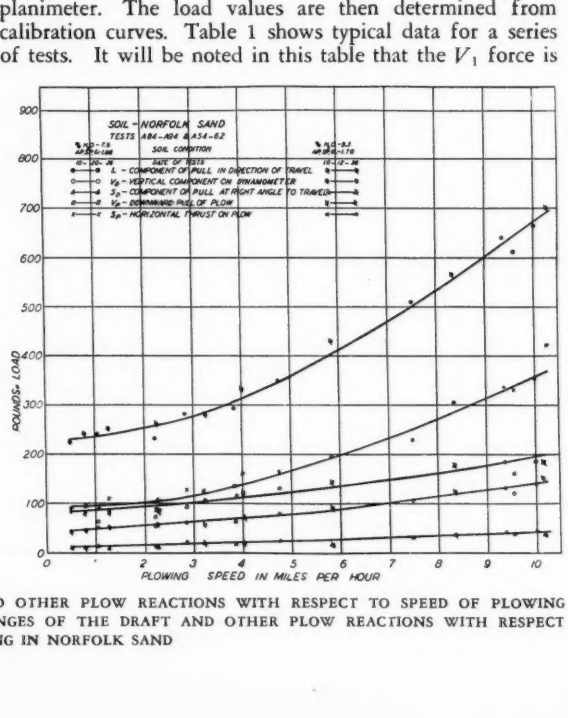

SOIL - NORFOLK SAND
TESTS A84 - A94 & A54 - 62
SOIL CONDITION
DATE OF TESTS
L - COMPONENT OF PULL IN DIRECTION OF TRAVEL
V_p - VERTICAL COMPONENT ON DYNAMOMETER
S_p - COMPONENT OF PULL AT RIGHT ANGLE TO TRAVEL
V_p - DOWNWARD PULL OF PLOW
S_p - HORIZONTAL THRUST ON PLOW
POUNDS LOAD
PLOWING SPEED IN MILES PER HOUR

FIG. 9 (LEFT) CURVES SHOWING THE CHANGES OF THE DRAFT AND OTHER PLOW REACTIONS WITH RESPECT TO SPEED OF PLOWING IN DAVIDSON LOAM. FIG. 10 (RIGHT) CURVES SHOWING THE CHANGES OF THE DRAFT AND OTHER PLOW REACTIONS WITH RESPECT TO SPEED OF PLOWING IN NORFOLK SAND

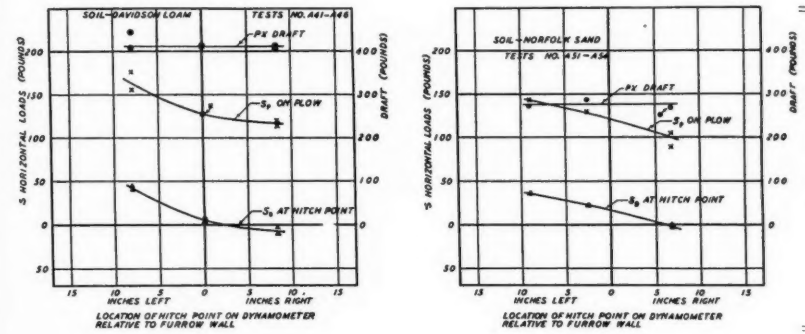


FIG. 11 CURVES TO SHOW THE CHANGES IN THE X COMPONENT OF DRAFT AND THE HORIZONTAL FORCES ON THE PLOW AND DYNAMOMETER WITH HORIZONTAL ADJUSTMENTS OF THE HITCH SETTING

negative and the V_r force is positive. This is due to the fact that, in addition to supporting the plow beam, these two forces act as a couple to overcome the rotation force caused by having the hydraulic unit measuring the horizontal pressures, S_p, above the center of the resultant of these forces. However, it will be found the algebraic sum of the forces exerted by the S_p reaction on V_1 and V_r is equal to zero, and hence the algebraic sum of V_1 plus V_r minus the weight of the plow on these cells, equals the net V reaction of the plow bottom measured at this point. The width of cut is not a variable as the dynamometer and plow are set over exactly the same distance for each test. Note that the depth varied but slightly. This leaves speed as the only variable for this series, except for the last test in which it was noted that the plow did not shed properly. This then explains why the data for this test is higher than for the next higher speed. These data for Davidson loam soil in this one condition are shown graphically in Fig. 9. From these data it is evident that for this one soil condition nonshedding became a problem some place between the speed of 1.0 and 0.25 mph. Tests at a later date established 0.75 mph as the critical speed for this one soil condition. Observations indicate that this critical speed will vary from soil to soil and with the physical condition of a given soil.

Fig. 10 presents graphically the same type of data for Norfolk sand. The two sets of data presented for the soil show that slight changes in the physical condition of this soil affect the magnitude of the several reactions slightly but do not affect their trends. The curves were drawn for the data obtained from tests made October 20, 1936. It will be noted that both the apparent specific gravity and moisture content of the soil were slightly higher for the tests made October 12 and that the points for these data show that the reactions were slightly higher for this series of tests. However, the variations in soil conditions and the plow reactions are small and show the possibility of duplicating both soil physical conditions and results. A comparison of these data with those for the Davidson loam soil in Fig. 9 shows that the different type of soil not only changes the magnitude of the reactions but also varies their rate of change with changes in speed. Fig. 11 shows the same comparison in soil variations with hitch setting as the plow variable instead of speed. The small amount of data presented does not enable drawing any conclusions or establishing trends for soil or plow variables. However, they do show that, with the equipment available at the farm tillage machinery laboratory, soil physical conditions and test results can be duplicated. They show also that data can be obtained that will enable evaluating and correlating the dynamic properties of the soil and plow shape and methods of operation with the actions and reactions of the plow bottom.

TABLE 1. SOIL — DAVIDSON LOAM

Plow bottom — G A 14 special, without landside, coulter on frame separate from beam and cutting 4½ in deep. Width of cut, 14 in.

Hitch setting — 22 in above bottom of furrow, ¾ in to right of furrow wall

SOIL CONDITION—				Date 10-13-36
Range	0 - 2	2 - 4	4 - 6	6 - 8
Per cent water	8.2	10.3	11.5	13.0
Apparent specific gravity	1.63	1.66	1.65	1.69

Test No.	Average depth, in	Speed, miles per hour	Draft components			Plows reactions			
			L	V_a	S_a Toward plowed land	V_1	V_r	$\frac{V_1}{V_r}$	S_p
A 66	6.7	10.2	900	176	57	—113	304	191	504
A 67	6.7	9.9	895	168	51	—109	342	233	407
A 68	6.7	7.4	599	111	29	— 68	164	96	246
A.69	6.7	5.5	468	93	23	— 37	137	100	175
A 70	6.7	3.15	331	69	17	— 20	117	97	130
A 71	6.5	1.04	282	60	14	— 21	84	63	110
A 72	6.4	0.25	410	86	12	— 56	80	24	135

*Not shedding at this speed.

Fifteen-Minute Concrete

MANY inventions are so simple that we wonder why they weren't thought of before. Such a one is the process for making vacuum concrete. By this method a dry, hard concrete can be made in fifteen minutes and after one week the material is between 53 to 82 per cent stronger than ordinary concrete.

The method, according to the Architectural Record, was invented by Karl Paul Billner and consists of laying rubber mats on the concrete immediately after it is poured. There are perforations in the under side of the mats which lead to small nipples. A hose leads from the nipples to a suction pump and action of the pump sets up a vacuum. The effect of this is to compress the mix evenly and surely in such a way as to bring out all the water, which is then drawn off through the perforations. Hardening takes place while the mass is being compacted. Air holes are eliminated.

The method will save $5,000 a mile in laying concrete roads and put the roads into service two weeks sooner. Great savings will be brought about wherever concrete is used.

Many scientists tackled Billner's problem in the past and Billner himself was side-tracked into making another discovery which he has called "Aerocrete." This is a concrete blown up by gas which is light enough to float and yet strong enough for many construction jobs. The offices of the National Broadcasting Company in Rockefeller Center, New York and many other buildings were built with aerocrete.—*Science Digest.*

Engineering Studies of Farms for Maximum Efficiency

By N. A. Kessler

IN THE past a considerable amount of attention has been given to research and investigation along the several lines of agriculture with splendid results. These studies have resulted in an increased production per unit, higher quality products, and a decrease in production costs. They are being continued, with even better results expected.

A field of study which has scarcely been touched is that in which all of these lines are studied as a balanced whole, on individual farm units. In 1929 a project since called "Farm Operating Efficiency Investigations" was initiated by the USDA Bureau of Agricultural Engineering, in which agricultural engineering studies are made on reorganized farms, and in which all agricultural branches are balanced one with the other as nearly as possible, to the end that when developments have been completed, operation can be at maximum efficiency.

Under this plan, practical studies can be made of individual problems, correlations of the various branches, and of the farm as a whole. This project has been expanded until, at the present time, over one hundred farms in seven states are included in the study. Agricultural engineering and farm management divisions are cooperating in this study.

In developing a program of this kind, representatives of the cooperators are present. Divisions other than agricultural engineering and farm management may take part in the project. The program for a given farm is based largely on the type of farming in which the farmer is interested, and which is suited to the conditions prevailing in a given area. It is obvious that the farmer must have as large a part as possible in the development of the plan, if his highest interest and enthusiasm is to be won. When the goal has been set, the farmer can proceed with development plans with a minimum of wasted time and effort.

The value of this project lies in the fact that studies are made of individual farms for which recommendations, based on research and investigational findings, have been made to fit each individual case. This is a departure from the statistical method in which, to a large extent, studies of farms are made by groups.

The scope of this study can be fully appreciated when reorganization plans are made for a farm having a variety of problems. The simple process of rearranging fields may be complicated by a variety of soils or soil conditions. The purchase of farm machinery may involve buildings, farm power, and economics. The extension of a power line may involve new building construction or changes in the old, the purchase of new equipment, or both. Soil erosion control may take land out of production, or the construction of terraces, contour farming, or strip cropping may increase the cultivable acreage. In the former case machinery or reforestration may be involved, and in the latter, new buildings, machinery, or fences. Efficiency studies may be made which include the activities of the farmer in performing his daily tasks throughout the year. While this may appear to be carrying the study to extremes, the human equation is admittedly a large factor in the farming business. How far it might be possible to go into studies of this kind is problematical. It is possible that, as farmer cooperators become thoroughly familiar with the potential possibilities of the project for their personal gain, they will keep records which are now difficult and costly to obtain.

When the improvement and development needs of a given farm have been determined, plans should include the order in which they are to be carried out. In most cases this problem is comparatively simple and hinges largely on finances. In some cases, however, the problem can be a difficult one involving several, if not all, of the cooperators.

In the timber sections, where cut-over land is being developed, an adaptation of this project to such conditions has been made. There are a number of questions, in connection with the development of a cut-over farm, which have not been completely answered. A project of this kind has been initiated in Minnesota, in cooperation with the USDA Bureau of Agricultural Engineering. In this project, a progressive development plan is laid out, so that a crop rotation is planned for each stage of development. Buildings, machinery, and power are added as the increased cleared acreage requires. Drainage and erosion control improvements are made as conditions require or finances permit.

The measure of results can be determined by before-and-after studies on each farm, and, where possible, by comparison of income before and after improvements and development have been completed. Studies of efficiency in working fields, before and after field changes and improvements have been made, should give some measure of results for that part of the program. Studies made of the various operations, such as corn harvesting, silo filling, hay making, and others peculiar to the different agricultural sections, will determine the advantages of newly purchased equipment, of the addition of new structures, or of new practices. Studies also may be made in the farm home, where efficiency has been increased by the addition of electrical or other equipment, or where alterations are made in the farm home whereby steps may be saved.

The conclusions drawn from the results will necessarily be for the farm as a whole. Conclusions, however, may also be drawn for any individual studies which may be made. Since this project is necessarily one of long duration, reports of completed individual studies may be made where information of immediate value and interest has been obtained. These reports will also supplement progress reports which are made from time to time.

The following tabulation of subjects indicates the various studies which may be made either individually, or in relation to the others or to the project as a whole.

1 Buildings
- (a) Arrangement in the farmstead
- (b) Design and construction of new
- (c) Requirements on an acre basis
- (d) The relation of building convenience to the labor and the amount of shelter per livestock unit.

(Continued on page 121)

A contribution (June 1936) of the Committee on Individual Farm Land Unit Investigations of the American Society of Agricultural Engineers—N. A. Kessler (chairman), J. T. Copeland, M. R. Lewis, E. R. Raney, and G. R. Shier.

Load Studies on Tillage Tools

By A. W. Clyde

A PREVIOUS paper[1] has described the tillage meter used for measuring forces on tillage tools. It also gave the purpose, scope, and methods of the study, together with some results and conclusions. The objectives of this project are to get information needed for

1 Proper hitching (or application of the pulling force)
2 Designing for strength and rigidity
3 Determining best shapes for tools.

Similar studies by Dr. George Kuhne of the Technical Academy, Munich, Germany, and at the USDA Tillage Machinery Laboratory, Auburn, Alabama, are under way or being planned, with well controlled soil conditions. Differences in soil and climatic conditions may justify some duplication of tests in different localities. The Pennsylvania State College, however, is working mainly on large differences or tendencies, on the principles involved, and on their application. Small differences cannot be considered because soil variables are not under control. The eastern section of the country is one which imposes rather large loads on tillage tools because of heavy soils and stony areas. For this reason it is a good place to study probable maximum loads and their influence on design.

Since the measuring of forces on farm tools is rather new, considerable attention has been given to operating technique and to the method of presenting the results. As a result of experience gained in 1935, the tillage meter was rebuilt and enlarged before the 1936 season, so that it could better accommodate a variety of tools. The pressure cells were improved so that the force indications are not as dependent as formerly on an exact position for the diaphragm. The new construction with a gap 3/8-in wide over the diaphragm is shown in Fig. 1. Other changes were the addition of a depth shoe and a shoe to help carry the side force.

The following tools were tested the past year:

1 Moldboard plows of speed type and of conventional shape at 2½ and 4½ mph (miles per hour).
2 Moldboard plows with rolling colter, and combined colter and jointer, in moist and dry sod.
3 Moldboard plow with USDA self-aligning disk jointer, in moist and dry sod.
4 Disk plow, 24 in.
5 Disk harrow, 18 in.

Tests were continued by the pulling method.

Before giving results of tests, an explanation is in order of how the soil force, or resistance, is determined with six dynamometers, and of how it may be given as two nonintersecting forces, or as a force and a couple. In Fig. 2, the six forces S_1, L_1, L_2, V_1, V_2, and V_3 are used to move a tool through the soil. They therefore balance the useful soil force (including a couple, if any) on the tool. The plow is run without landside, and with the gunnel of the share relieved, so that practically all side force is carried by S_1. The vertical forces are those required on a weightless outfit, weight having been deducted. L_1, L_2, and S_1 are first combined to find their antiresultant. It acts on the line of ABC and has a magnitude of BC. The force V_4 which will balance the three vertical forces is then found and located as shown. (It may in other cases be back of V_3, as well as on the other side of the center line). If V_4 is located on the line of BC, e.g., where V is shown, it can then be combined with BC, giving R, the resultant soil force on the tool. R can be placed anywhere on its line of action, the place where shown in Fig. 2 being only one of convenience.

With plows and disks, however, V_4 usually does not intersect the line of BC. The common procedure is then to convert BC and V_4 into a force and a couple. This is done by adding equal and opposite forces V and V_5 at some point such as C. BC and V are combined into R, leaving V_4 and V_5 as a couple with a value Va acting in the plane of V_4 and C. The couple is usually put in a plane perpendicular to the direction of travel, though that is arbitrary. It should be noted, however, that R will have a different location and the couple value will be different if another plane is chosen for the couple. For some purposes it is convenient to apply R at some point near E and there change it and the couple back into a horizontal force and a nonintersecting vertical force. It is thus evident that such apparatus measures and locates the *total soil effect* on the tool. It does not, however, locate any one component of the total without regard to the location of the other components. It would be equally permissible to consider that L and V intersect and that the rotational effect is caused by S being nonconcurrent. An attempt to find what particular combination causes the total effect would require other apparatus, and for the present the total effect seems

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Presented before the Power and Machinery Division of the American Society of Agricultural Engineers at Chicago, Ill., Nov. 30, 1936. Authorized for publication on December 30, 1936, as paper No. 752 in the Journal Series of the Pennsylvania Agricultural Experiment Stations.

Author: Agricultural Engineer, Pennsylvania State College. Mem. ASAE.

[1] Measurement of Forces on Soil Tillage Tools, AGRICULTURAL ENGINEERING, vol. 17, no. 1, January 1936.

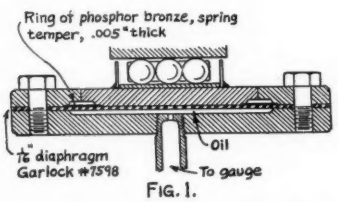


FIG. 1.

FIG. 1 (ABOVE) IMPROVED CONSTRUCTION OF HYDRAULIC PRESSURE CELLS. FIG. 2 (RIGHT) METHOD OF COMBINING SIX FORCES FOUND WITH THE TILLAGE METER INTO A RESULTANT FORCE AND A COUPLE, IF ANY

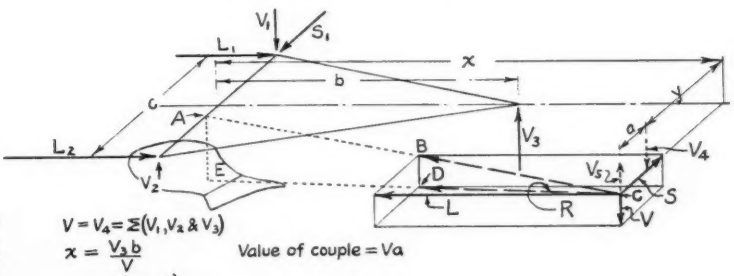
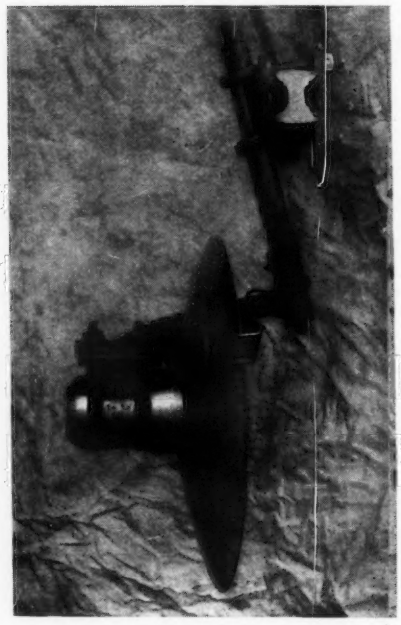


FIG. 2.



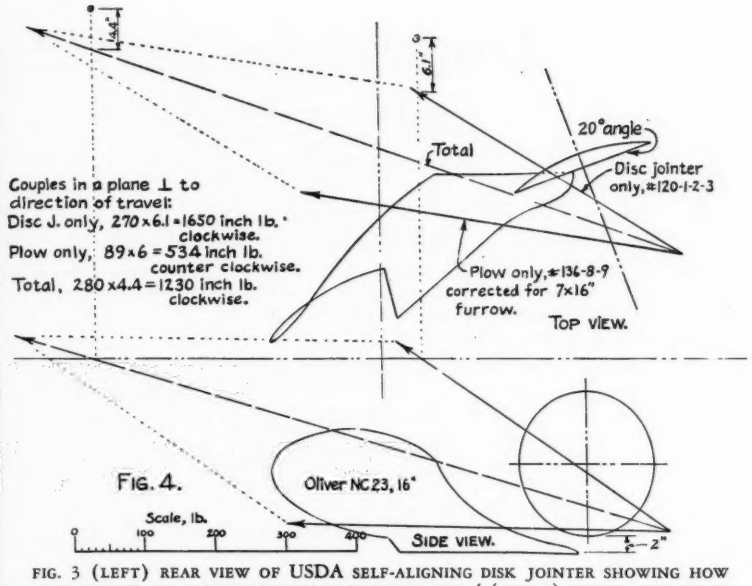

Couples in a plane ⊥ to direction of travel:
Disc J. only, 270×6.1=1650 inch lb. clockwise.
Plow only, 89×6=534 inch lb. counter clockwise.
Total, 280×4.4=1230 inch lb. clockwise.
Total
20° angle
Disc jointer only, ≠120-1-2-3
Plow only, ≠136-8-9 corrected for 7×16" furrow.
TOP VIEW.
Oliver NC 23, 16"
Scale, lb.
0 100 200 300 400
SIDE VIEW.
2"

FIG. 4.

FIG. 3 (LEFT) REAR VIEW OF USDA SELF-ALIGNING DISK JOINTER SHOWING HOW IT IS PIVOTED ON AN AXIS INCLINED SIDEWAYS. FIG. 4 (ABOVE) USEFUL SOIL FORCE ON A PLOW WITH THE DISK JOINTER, SHOWING HOW IT IS DIVIDED BETWEEN THE TWO IN RATHER DRY SOD PLOWING

to be much more useful than knowledge of the exact combination causing that effect.

Occasionally V_4 (or V) may equal 0. Such a case can be handled by taking moments about a transverse and a longitudinal axis to determine how far S and L, respectively, are located below the reference plane.

The 1935 report gave some information about couples on plows. Unless noted otherwise, the couple will be in a plane perpendicular to the line of travel and its sense of rotation will be as viewed from the rear. The useful soil force on a right-hand plow apparently always includes a counter-clockwise couple. It should be noted that the soil force on the landside is not included in the above, but that it and the forces on the wheels must be included in considering a complete plow. Under a condition like Fig. 8c, the side force on the landside or furrowwheel would be below the useful soil force and would reduce or reverse a clockwise couple. On all disk tools studied, the couple has had a clockwise sense with right-hand disks. This is what has to be considered with the useful soil force when figuring the load on a disk or on its bearings. For the stability of the complete implement, however, the force which prevents it from moving sideways must be included as mentioned for a plow.

Tests and Results. Tests comparing the speedtype and the conventional general-purpose bottom were made in sod having 10.3 per cent moisture. With the speedtype plow, L, the longitudinal component of the useful soil force, was less at both $2\frac{1}{2}$ and $4\frac{1}{2}$ mph than with the plow of more conventional shape. The average L of both bottoms at $4\frac{1}{2}$ mph was about $14\frac{1}{2}$ per cent higher than at $2\frac{1}{2}$ mph. Little difference was observed in the work done at the lower speed. At the higher speed, however, the conventional plow threw the soil farther sideways and turned some chunks of soil a full revolution, leaving them right side up.

Two series of tests were made by A. H. Glaves, USDA Bureau of Agricultural Engineering, and myself, on the self-aligning disk jointer developed by Mr. Glaves. The novel feature of this tool is the pivoting of the disk about an axis inclined 18 deg to one side of the vertical, as will be seen in Fig. 3. It is free to swing about the axis until the side soil force on it is balanced by the side component of pull from the pivot, plus some side support furnished by the furrow wall. The location and inclination of the axis permits the disk to swing to the right and upward if it strikes an obstruction. It is, therefore, quite safe against damage by stones.

The purpose of the tests was to study certain features entering into design, such as bearing loads, direction of soil forces, etc., together with observations on how much load this tool removes from the plow, and how it may affect hitching. One series was in dry sod and included a rolling colter and a combined colter and jointer. The forces on the attachments and on the plow bottom were each measured when working together, and, as a check, the total forces were measured on the combinations. A second series was run in very moist sod. Fig. 4 gives typical forces in dry sod at 3 mph. These confirmed the saving in draft found elsewhere with the disk jointer. When cutting 5 in deep in 7 in plowing of nearly dry sod, it reduced the plowing draft about 12 per cent below that using a colter and jointer. The total side force, when using the disk jointer, was greater. The disk jointer broke loose much soil ahead of the plow. It used 40 per cent of the draft, leaving only 60 per cent for the plow (using "draft" for the directional component only). Tests were also made at other depths, and with the disk mounted rigidly instead of being pivoted.

An observation was made regarding rolling colters which was new to me. A common rolling colter, with or without a jointer, would not run straight, but would swing to the right. The undisturbed soil on the left side furnished more side resistance than the loosened soil on the right. This no doubt explains why a rolling colter is set as much as $\frac{3}{4}$ in to the land in order to get a clean furrow. Apparently it does not run in that position but swings over more nearly above the plow point.

One use of the disk jointer tests was the calculation of bearing loads. For this purpose the force and couple of Fig. 4 were converted into two forces, one radial and one

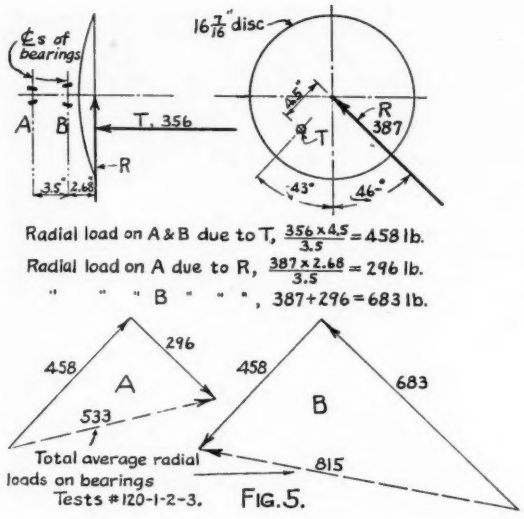


FIG. 5.

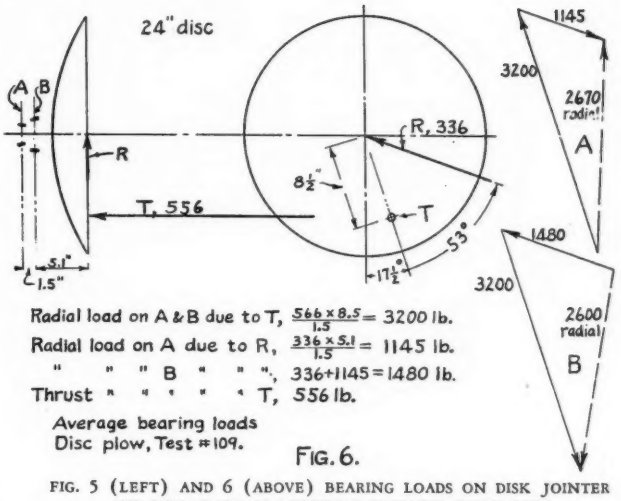


FIG. 6.

FIG. 5 (LEFT) AND 6 (ABOVE) BEARING LOADS ON DISK JOINTER AND DISK PLOW IN DIFFICULT PLOWING CONDITIONS

thrust, as in Fig. 5. The tangential component which turns the disk has been omitted as insignificant when antifriction bearings are used. As previously mentioned, a force and a couple can be converted into two nonconcurrent forces. The radial bearing load caused by each is computed and the loads then added vectorially since they are not in the same direction.

In the disk plow tests, the upward soil force, $-V$, was not as great as was expected when working in nearly dry sod. It was greater per square inch of furrow than with a sharp moldboard plow and rolling coulter, but was less than that observed with a plow and disk jointer set 2 in over the point in similar soil conditions. This raises the question as to whether the great weight of disk plows is really necessary. Some of it may be needed to overcome the added upward V when the disks are dull. Further study may show, however, that the weight has not always been at the best location and that less weight properly located will suffice.

The main purpose of the disk plow tests was to determine the loads on the disk bearings. Fig. 6 gives the bearing load calculation for the most severe test after the soil force has been converted into radial and thrust forces on the disk. The tangential component was also insignificant here. This test was in moist heavy silt loam sod with about 1 in of clay loam at the bottom of the furrow. The disk was cutting 9.2 in deep and 10.2 in wide, giving a furrow crosssection of 86.2 sq in. A scraper was used but the force on it was not measured. The disk was angled 45 deg and had 21 deg back tilt. The longitudinal soil force was 625 lb, side force 180 lb, vertical force 97 lb downward, and the couple was 2070 in-lb clockwise. Attention is called to the large bearing loads caused by their close spacing and the large lever arms of the forces. Although space for bearings back of a disk plow is very limited, it seems easily possible in this case to increase the spacing ½ to ¾ in. That would reduce the loads considerably. A similar test in dry sod resulted in larger forces on the disk but in smaller bearing loads. This is due to different distance and angle relations between the radial and thrust forces.

The soil forces on an 18-in disk harrow under several conditions of loading have also been converted into radial, tangential, and thrust forces. Their position and magnitude vary from those given in Fig. 5 and 6, but the general characteristics are similar. A noteworthy difference with disk harrows is the size of the tangential force needed to overcome bearing friction.

Using Results in Hitches. The problem on which our results have been of most immediate use is that of hitches, or deciding on the location and direction of the pulling force. Two previous articles[2, 3] have explained the mechanics involved. Recent tests have shown the effects of changes in hitches and something of the practical limitations within which changes can be made.

Unfortunately most of the printed instructions about plow hitches have been incomplete or wrong. This applies equally to bulletins of public institutions and to manufacturers' instructions. Such terms as "draft," "sidedraft," "true line of draft," "center of resistance," etc., have often been used without a clear definition of their meaning. Clear thinking in regard to the behavior of implements demands that such terms be either clearly defined or abandoned. The American Society of Agricultural Engineers could prevent much confusion by standardizing such terms, which now are ambiguous.

The commonly used rule for plow hitches is that in both horizontal and vertical planes the pull should be directed toward a point on the plow called the "center of resistance." For the horizontal hitch, this point is said to be near H, Fig. 7. This is often true, but it is important to know what locates point H. In reality it is the intersection of the useful soil force R_1 and the landside force Q. The pulling force must pass through H for equilibrium. When, however, a very long landside or an effective rolling landside is used, this intersection will be farther back, as to H_1, and P must be relocated. P need not be in the direction of travel, but can be angled to either side within limits. Any change in direction of pull will change the magnitude of both Q and P because of changed friction drag on the landside. In Fig. 9, a plow with a very long landside is being pulled by a chain which lines up nearly with the furrow wall. The force intersection has been moved back and to the left. Similar field tests have been made with a rolling landside. This effect has practical use in pulling a narrow plow with a wide tractor.

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[2] Mechanics of Plow and Tractor Hitches. AGRICULTURAL ENGINEERING vol. 15, no. 11, November 1934.

[3] Vertical Hitching of Farm Implements. AGRICULTURAL ENGINEERING, vol. 16, no. 9, September 1935.

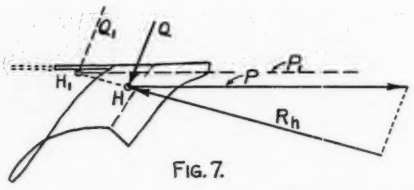


FIG. 7.

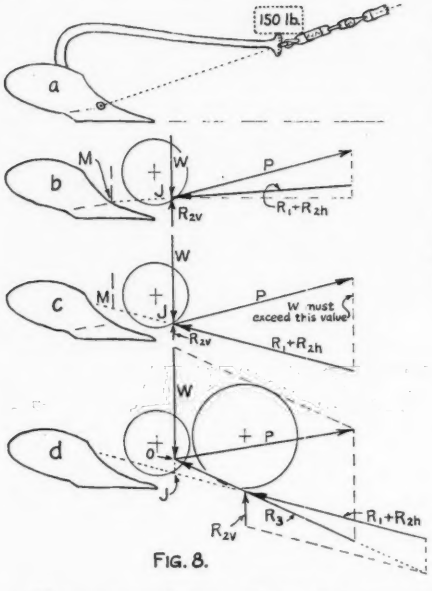
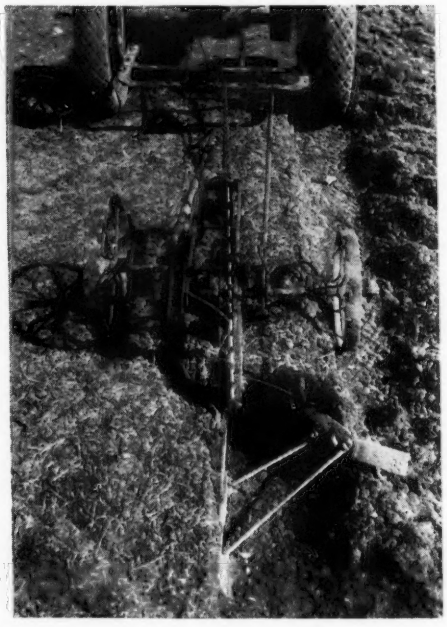


FIG. 8.

FIG. 7 (TOP LEFT) AND 8 (BOTTOM LEFT) FORCE RELATIONS ON A PLOW IN THE HORIZONTAL AND VERTICAL PLANES; b IS FOR EASY PENETRATION, c AND d FOR DIFFICULT PENETRATION. FIG. 9 (RIGHT) PULLING A PLOW WITH A CHAIN TO SHOW THAT THE LONG LANDSIDE MOVES H_1 NEAR THE FURROW WALL. WITH THE SAME SOIL CONDITIONS BUT WITH THE REGULAR LANDSIDE, H, WAS NEARLY IN THE CENTER OF THE CUT



The greatest failure of the above-mentioned hitching rule has occurred when it has been applied to the vertical plane, as in Fig. 8a. It is then easy to show that it has only limited application. Suppose the rule is followed with a walking plow, and that a heavy weight is then added to the doubletrees or front end of the beam. It is obvious to anyone with plowing experience that the rule is no longer useful; the hitch must be changed. If an equal upward force is applied to the plow handles, a still further change in hitching is required. In this case the weight has in effect been unchanged, only the center of gravity has been moved. This shows that any rule that neglects the weight or center of gravity of a plow, is a faulty one. The reasons the old rule has worked as well as it has, are because walking plows usually have the center of gravity, including weight of doubletrees, a little back of the plow point, and because rolling colters are seldom used on walking plows.

In applying the old rule to wheeled plows, it is common to encounter a different weight distribution, also a different soil force because of rolling colters or a disk jointer. Fig. 8b is a typical condition for a plow with colter when penetration is easy. $R_1 + R_{2h}$ is the useful soil force plus the parasitic friction. If P is passed through J, the upward soil reaction, R_{2v}, on the wheels, will also be at J, and the proportional loading on front and rear wheels will be unchanged. The condition of Fig. 8c is typical when penetration is more difficult. Sled-runner shares, rolling colters in hard ground, or a deeply set disk jointer, contribute to making the soil force slant upward. Obviously this may change the intersection with the weight line, especially if the center of gravity is at M instead of ahead of the plow point.

It will be realized that some shift in loading of front and rear wheels is permissible. Fig. 8d shows this carried to the limit by raising P until R_{2v} is at the front wheels. All load has been removed from the rear wheel and the plow is ready to "run on its nose." It is easy to determine, either graphically or by a moment equation, how R_{2v} will be shifted to the front or rear as P is moved up or down. The principle to be used is that the total soil force, R_3, must be in equilibrium with W and P. It should be noted that W may not include all of the wheel and axle weight because the beams can often be raised without lifting the wheels. For this purpose W should include only what must be lifted to raise the beams slightly.

It seems desirable to get better terms for what has been called the "center of resistance," because of the wrong associations which that term has. Actually, two distinct force intersections are being dealt with, one in the horizontal plane, and a different one in the vertical plane. For plow users the old rule might easily be revised to give consideration to the center of gravity and the effect of rolling colters in hard ground. Many have used the method of grasping the moving wheels and judging the weight being carried by each. Practically this is very useful. It takes into account the weight of the tool, which the "center of resistance" method failed to do. Point J does not shift much when W is a few inches ahead of the plow point. The shift is greater when W is farther back. Better instructions for the user might suggest a trial point for which the pull can be aimed, then suggest what symptoms to watch for and how to correct any bad condition. "Running on the nose" due to too high a pulling force is probably as common a fault as any with tractor plows.

Using Results for Shop Tests. Another use for information about soil forces is for setting up shop tests, in which part of an implement will be loaded in a manner similar to its loading in use. For example, if a disk is to be tested it is not enough to apply one load. It must have at least two loads, and we now have information about the locations and amounts of the loads under rather severe field use. Another example might be the shop testing of a plow beam or frog. Suppose the old part has met field use satisfactorily, but for some reason a new design is preferable. A shop

test simulating field conditions might give the comparative merits of two designs much more quickly and economically than field trials. The Pennsylvania Agricultural Experiment Station is now able to suggest to manufacturers how some test should be set up to compare new and old designs in strength and rigidity, and expects soon to have more such information available. Usually, as in the case of disks, two loads will usually be needed to give the twisting or couple effect which is so common.

Thus far the study has been of the forces involved in steady operation. When a solid obstruction is hit, the situation is much changed, and inertia effects enter. It is hoped that attention can be given that phase of the problem after the study of steady operation has progressed farther.

SUMMARY

1 The mechanics of finding the useful soil force on a tool, (or the combined useful and parasitic friction forces, if desired), are explained.

2 The useful soil force on plows and disks is usually made up of non-concurrent parts. They can be combined into two non-concurrent forces, or into a resultant force and a couple, as desired. Information as to particular tools under certain conditions is given.

3 The speed type moldboard plow required less draft at both 2½ and 4½ mph than the one of conventional shape. At the higher speed the speedtype bottom did a better job of covering.

4 The USDA self-aligning disk jointer in heavy plowing gave a substantial reduction in total draft, but an increase in side force, as compared with colter and jointer equipment. In 7-in plowing with the disk set 2 in over the point, the disk used over 40 per cent of the draft, leaving less than 60 per cent for the plow. The self-aligning feature protected it from damage by stones.

5 Examples are given of using soil force measurements for computing bearing loads on the disk jointer and disk plow. Wide spacing of bearings reduces the loads because of the overhanging nature of the forces.

6 The commonly used "center of resistance" rule for plow hitches is wrong, because it takes no account of the weight of the tool, nor of varying soil forces. Suggestions are given for a rule which will be of more universal application.

7 Data on soil forces permits the planning of shop tests which will load an implement part in a manner similar to its field loading. Usually at least two forces must be supplied to give the couple or twisting effect so often present.

ACKNOWLEDGEMENT: Credit is due Prof. K. J. DuJuhasz. Pennsylvania State College, and A. H. Glaves, U.S.D.A. Bureau of Agricultural Engineering for assistance in apparatus, methods, and tests.

Engineering Studies of Farms for Maximum Efficiency

(Continued from page 116)

2 Drainage
- (a) Need for, correlated with soil management and crop programs
- (b) Surface, correlated with erosion problem
- (c) Deep
- (d) Outlet
  - (1) Individual
  - (2) District
- (e) Importance of drainage to other farm improvements.

3 Erosion prevention and control
- (a) Correlated with soil management and crop programs
- (b) Correlated with field arrangement
- (c) Correlated with land clearing with special reference to clearing of stream banks and resulting danger of bank erosion
- (d) Correlated with drainage
- (e) Correlated with irrigation
- (f) Correlation with livestock.

4 Electrification
- (a) Its effect on farm labor requirements
- (b) Effect on operating intensity
- (c) Correlated with machinery
- (d) Correlated with home conveniences
- (e) Correlated with water supply
- (f) Correlated with crop and livestock programs
- (g) Correlated with irrigation with special reference to the possibility that irrigation pumping may help finance line extensions, also general-purpose motors.

5 Field Arrangement
- (a) Correlation of shape and size of field and efficient operation of machinery.

6 Fencing
- (a) Relationship between fenced fields and unfenced fields as production factors
- (b) Effect of fencing on land use.

7 Home Conveniences
- (a) Their effect on family morale
- (b) Effect on efficiency of labor supply.

8 Irrigation
- (a) Correlated with soil management and crop programs
- (b) Correlated with livestock program with special reference to irrigated pasture
- (c) Correlated with rural electrification with special reference to a possibility that irrigation pumping load may finance line extensions and also general-purpose motors
- (d) Correlated with soil erosion prevention and control
- (e) Correlated with water supply as the same well may be used
- (f) Irrigation studies for the humid regions
- (g) Correlation with type of farm development.

9 Land Clearing
- (a) Use of delayed or forced systems
- (b) Method to be used
- (c) The value of stump and stone removal in permanent pastures
- (d) Stone disposal
- (e) Importance in relation to other needs of the farm.

10 Machinery
- (a) The causes of depreciation and methods of controlling it
- (b) Economic life
- (c) Amount needed for a given farm
- (d) Correlation with labor requirements.

11 Power
- (a) Correlated with farm development
- (b) Value of various kinds under a given farm set-up.

12 Farm Roads
- (a) Correlated with field arrangement
- (b) Correlated with fencing
- (c) Correlated with irrigation
- (d) Correlated with surface drainage
- (e) Correlated with erosion control
- (f) Correlated with buildings (site and arrangement).

13 Labor
- (a) The effect of supply on the development of imptovements.

Farm Houses That Farm Families Want

By Ruby M. Loper

FARM buildings throughout Nebraska are in a very bad state of repair. Two factors contribute to this condition. The state is now in a period of its development when the structures built in an early day have reached the end of their normal life span. Also, many buildings which would have given good service for another 10 or 15 years, if they had had adequate maintenance, have had deterioration hastened by lack of care and repair. The break in prices paid for agricultural products in 1921 found many farmers so deeply in debt that the increased returns during 1924 to 1929 were, of necessity, applied on loans incurred during war time. Consequently, there was left no surplus for the construction of new buildings or for adequate maintenance of old ones. This maintenance gradually shrank until 1932, since when it has been practically nonexistent. Weather conditions of the last four years have added their ravages, until now Nebraska farmers are faced with the task of rebuilding a very large percentage of their barns, sheds, and houses. Two years of good crops sold at fair prices would result in a period of building activity never before equalled in the state.

Just to show what this would mean in the consumption of building materials, reference is made to the farm housing survey conducted by CWA in 1934. This survey covered 10 per cent of the counties, so chosen as to be representative of all parts of the state, and from the figures obtained, estimates were made for the entire state and pertains only to materials needed to repair existing farm homes. No new construction was included, nor were any of the service buildings listed. At that time 3,200 carloads of shingles were needed to make roofs watertight; 6,000 cars of cement to make foundations suitable for supporting the structures above; 2,000 carloads of siding, shiplap, and studding for the repair of exterior walls; 384 carloads of windows to keep out the weather; 270,000 gal of paint on the outside, and 122,000 gal on the inside.

Only in a very few cases has it been possible to make any of these needed repairs, and consequently the figures are even larger now than they were two years ago. This coming construction activity presents a very real challenge to anyone engaged in rural structures work, and we in Nebraska felt that if we were going to discharge our obligation honestly, we must be ready to be of the best possible service.

Too many farm homes have been built in the past with little or no thought given to the requirements of and activities connected with farm life. City homes transplanted to the farm simply do not work, and oftentimes have resulted in great inconvenience for the housewife.

In working with groups of farm women in all parts of the state during the past two years, it has become increasingly evident that these women are fully determined to have better homes and more conveniences just as soon as finances permit. Their universal argument is that they have labored, saved, and deprived themselves and their families in order to purchase more land. Now this same land has either been lost, or is proving to be a heavy liability. If part of this money had been invested in a water system for example, it could have been enjoyed by all members of the family and would still be good for many years.

In order to be ready for this period of building when it comes, we decided to take stock of what we had to offer. We wanted to know if we had plans available which would be adaptable to all parts of the state, from the cattle ranch in the west to the dairy farm and truck garden in the eastern end. Did we have designs suitable for families of different sizes and means? And, above all, did our plans contain conveniences and arrangements which farm families actually wanted, or were they merely the embodiment of what we thought they wanted? In order to find out just what farm women themselves would want, questionnaires were sent to 5,500 homemakers whose names had been submitted by agricultural and home agents. These names were selected carefully to include both owners and tenants, young women and elderly women, those whose families were of different sizes, different nationalities and those of different educational backgrounds, as well as those of different economic brackets.

At the present time, approximately 30 per cent of these questionnaires have been returned and the answers are extremely gratifying. It is easy to see that in numerous cases they have been discussed and answered by the entire family. The splendid efforts put forth by some of the farm papers and women's magazines were reflected in many of the answers. A complete summary has not been made as yet, but 10 per cent from each county have been tabulated and following are some of the results:

1 The amount these families would be willing to spend in normal times varied from $1,500 to $8,000.

2 Over 50 per cent were in the $3,200 group, with $3,500 running a close second, and $4,000 next in line. It is of interest to note that the $3,500 and over answers were almost entirely from owners, while the tenants were from $3,200 on down. Surprising as it may seem, the items checked for inclusion were, in most cases, possible for the amount indicated.

3 Wood construction was the favorite, with brick next.

4 There was about an even division between one and two-story houses.

5 Basements were desired in a very large number. Negative answers to this question were nearly all from areas where water tables are high.

6 Central heating plants were listed for almost all basements. A note of explanation with these answers indicated a desire for furnaces of adequate size to permit the use of wood for fuel.

7 Recreation rooms were wanted in the basements. These should not be confused with the elaborate game rooms of city homes, but interpreted rather as places where harvest hands could be fed, community gatherings could be held, and children could play at the time of family reunions.

8 There was about an even division on the location of the laundry in the basement or in a utility room on the first floor.

9 The desire for running water was almost universal.

Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Chicago, Ill., December 2, 1936.

Author: Assistant extension agricultural engineer, University of Nebraska, Assoc. Mem. ASAE.

10 All answers specified weather stripping, and all but two wanted insulation. While this reflects to some degree the value of the advertising compaigns of materials manufacturers, the question arises as to whether the dust storms of recent years, the extreme heat of summer, and cold of winter might not also be partially responsible.

11 Screened rear porches for summer eating, reading, and resting were indicated in most cases. Glazing for these porches was wanted by about 50 per cent.

12 The floors for porches were mostly wood and linoleum when glazed, and concrete in the others.

13 Many indicated a desire for a farm office on the first floor, to which admittance could be gained either directly from the rear porch or through a rear hall.

14 Two bedrooms were wanted on the ground floor in the two-story houses.

15 Kitchen cupboards should be closed.

16 Separate dining and living rooms were listed by the older people, while a combination dining and living room was acceptable to the younger ones.

Many other questions were answered, and, of course, the tabulation of all answers may change the foregoing classifications.

What are we going to do with this material when the analysis is completed? It is to be used as a basis for the development of farm house plans which will contain the features farm families themselves have indicated they want. We are obligated to make these plans such that the family will get 100 per cent value for every dollar invested. Sound construction is, of course, the primary requisite, but convenience, livability, and beauty must also be included. We have solicited help from the department of architecture in working out the designs, and the department of home economics will be asked for criticism of arrangements. After preliminary plans are drawn, they will be sent to key homemakers in various parts of the state for criticism. Their suggestions will be studied and, wherever possible, incorporated in the final working drawings.

Opposition to plans furnished by colleges has been voiced by architects in some instances, but several factors exist which justify such work. In the first place, too few architects know the requirements of farm homes. Next, most farmers are not going to have any extra money with which to pay for architectural service, and in many communities no such service is available. Also, some of them would not hire an architect if it were possible. We are all agreed on the value of the services the architect has to offer and, in cases where homes of $8,000 or so are to be built, people will be urged to employ one. But in ordinary times few architects want to bother with a $3,200 to $4,000 house, especially when it is to be located many miles away.

Experience in Nebraska has proved that lumber dealers will give wholehearted cooperation in getting the best buildings possible for the money available. Most of them realize that their prosperity is not dependent upon how large a bill of lumber they can sell in each case, but rather upon how they can help the farmer get the most for his money. The local lumber merchant can also be of inestimable help in getting the local carpenter to follow plans provided, rather than working in many of his own pet ideas. The carpenter whose first move in accepting a job is to work over the plan, usually manages to omit or spoil the most essential features, and thereby gets a disappointing result.

Sometimes the local carpenter is an open-minded, considerate fellow, and realizes that the farm woman might have some ideas of her own as to how she wants her home arranged, especially since she is the one who has to do the work in it. More often though, he states emphatically "I guess I know how to build a house and I don't want advice from any woman." Consequently, many homemakers have spent years in homes where there were too many doors in the wrong places, too few windows in the right places, not enough closets, kitchens that were most inconvenient, and work surfaces so low that one soon becomes permanently bent; and in rooms that were too large, too small, or poorly located for their intended use.

Plans sometimes have to be changed, that is true, but it is not the carpenter's job to do it. Changes should be discussed by the family and then submitted to one whose training qualifies him to be of assistance. Here again the lumber dealer oftentimes can be of great help.

Most families do not invest in more than one house in a lifetime, and mistakes in planning and construction cannot be corrected easily. Therefore it behooves those of us in farm housing work to give the farm families homes they want. Such plans cannot be prepared overnight, and if we are to be ready when hammers start ringing on almost every farm, intensive work must be done now.

What Agricultural Engineers Are Doing

REPORTED FROM *USDA* BUREAU OF AGRICULTURAL ENGINEERING

ENROLLEE and Bureau personnel from the CCC central district drainage camps have assisted in a wide variety of work in the flooded areas, providing labor for strengthening levees; sand bagging breaks and sand boils; loading supplies and equipment; transporting people and supplies; constructing rafts; operating boats; assisting in survey crews; guarding property; patrolling levees; and as cooks, guides, and messengers. Prior to assumption of control by the Army and Red Cross, effective organization and direction of evacuation and removal of marooned victims was carried on under the direction of Bureau personnel, both in the southeastern Missouri area and the Kentucky-Evansville area. Through February 15, a total of 12,210 enrollee man-days, 917 man-days technical service personnel and 1416 truck-days have been expended on this work.

* * *

F. E. Staebner visited Erie, Pennsylvania, where, in company with Oscar Erf of Ohio State University, he investigated a proposed project to irrigate some 575 acres of land in alfalfa, owned by a dairy farmer in that region. As a result of the inspection, detailed plans for irrigating a part of this land have been developed, and it is expected that the installation will be made during the coming spring.

* * *

At the request of the Resettlement Administration, Lewis A. Jones made an inspection of the Scuppernog Farms Project located near Phelps Lake, Washington County, North Carolina, and reviewed the proposed plan of drainage for the project.

* * *

Contributions Invited

All public-service agencies (federal and state), dealing with agricultural engineering research and extension, are invited to contribute information on new development in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

Preparation of the report on the Rio Grande study for the National Resources Committee was continued by Messrs. Blaney, Ewing, and Rohwer in the Berkeley office. D. W. Bloodgood prepared a description of irrigation in the Mesilla Valley, New Mexico, for inclusion in the report, and A. A. Young contributed a discussion of use of water by natural vegetation. The latter included a resume of previous investigations of use of water by natural growth and comparison with those undertaken during the summer of 1935, both in the San Luis Valley, Colorado, and the Middle Rio Grande Valley near Albuquerque, New Mexico.

* * *

Leslie Bowen presented a discussion on "Water Requirements of Some Crops under Irrigation," before an agricultural conference held at Denver, sponsored by the Great Western Sugar Company, and attended by field men, superintendents, managers, etc., of the company from the various territories in which it operates. At this meeting R. L. Parshall discussed the relation of irrigation water to sugar beet yields in northern Colorado, and referred also to the economic value of the Colorado-Big Thompson project.

* * *

A series of tests by I. F. Reed is under way at the Farm Tillage Machinery Laboratory, to determine the effects of size of plow bottom upon draft per unit width. These tests are being carried on in three soil types and at speeds varying from 1 to 7.5 miles per hour. The draft of the bottom, colter, and frame will be determined separately, then assembled to get the plow draft.

* * *

During the week of February 15, W. M. Hurst made a trip to Orange, Culpepper, and Richmond, Virginia, to inspect several grain and fungicide feeders which were constructed at these locations. This machine, designed by Bureau engineers, automatically applies specific amounts of dust fungicides to seed grain for controlling smut and other diseases.

* * *

A. D. Edgar recently returned from Aroostook County, Maine, where he inspected potato houses that had been used in previous experimental work. He reports much more difficulty than usual this year in the storage of potatoes, due to late blight before the potatoes were harvested, and bad weather conditions at time of harvesting. Conditions in the houses where he has carried on experimental work are, however, well above average. Owing to difficulties in storage and the high prices, it is expected that many farmers will improve their storages during the coming year.

* * *

On January 18 A. H. Senner gave a talk on "The Proper Installation of the Domestic Oil Burner," before the Baltimore Society of Air Conditioning, and on January 20 he presented a paper on bottled gas at the convention of the National Bottled Gas Association.

NEWS

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

ON January 25, President Roosevelt appointed John C. Page Commissioner of the Bureau of Reclamation to succeed the late Dr. Elwood Mead. Page is a Westerner intimately acquainted with the problems of conservation and the use of the meager water supply of the semi-arid and arid states.

He was born in Syracuse, Nebraska, October 12, 1887 and entered the Reclamation service soon after completing his engineering education. For more than 23 years he has worked in the Bureau, first on jobs such as would be assigned to any young engineer, and later as chief administrative assistant in the construction of Boulder Dam.

Dr. Mead called Mr. Page to Washington October 1, 1935 to assist him in the Commissioner's office as chief of the engineering division. Shortly after the death of Dr. Mead last January, Secretary Ickes appointed Mr. Page, the man Dr. Mead had chosen as his understudy, as temporary head of the Bureau of Reclamation. The new Commissioner is a Civil Service employee of the Bureau of Reclamation possessed of an extraordinarily varied experience as an engineer, builder and administrator, which makes him well qualified to head this great organization. In addition to his engineering and construction experience, Mr. Page has been a farmer both in the humid and arid climates.

* * *

United States Public Health Service reports made during the recent flood period disclosed the following unusual information: The U. S. Public Health Service coordinated its flood relief work with the American Red Cross, State Departments of Health, the WPA, the Coast Guard, the Procurement Division of the Treasury, the Bureau of Narcotics, the Alcohol Tax Unit and a number of other cooperating agencies. Medical officers and sanitary engineers were transferred from their regular posts to the flood areas with instructions to coordinate their efforts with state authorities, Red Cross personnel and other agencies. The Surgeon General's office became a clearing house of information as to the biologic resources of the nation and of medical requirements in all flood areas. A complete inventory was made of all biologic supplies including typhoid and small pox vaccine, vaccination needles and prophylactic doses of diphtheria and tetanus anti-toxin. Some idea of the magnitude of this undertaking may be gotten from shipping reports indicating the following quantities of biologic products: sufficient typhoid vaccine to vaccinate 330,000 people, enough small pox vaccine to innoculate 249,000 people, 11,000 doses of tetanus prophylactic anti-toxin, 70,000 doses of diphtheria toxoids for children, and 17,400,000 units, of pneumonia serum. *(Continued on page 126)*

RUBBER MARCHES ON!

DESIGN FOR GOODYEARS!

No development since the radio has aroused the farmer the way the rubber tire has—for tractors and implements.

Every questionnaire—every survey brings the same answer: *Farmers want rubber!*

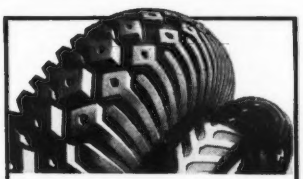
And, quite naturally, increasingly large numbers want Goodyear—the All-Traction Tractor Tire for tractors and the special Goodyear Implement Tire for drawn implements. On thousands of farms these great tires have proved their greater ability to save time and money, to do more work and to do it more easily.

Active dealers find the farmer ready to buy. And they find the added profits from this business very substantial.

Design your equipment for Goodyears! They will make your tractors or implements show up better on display or in demonstrations—make your equipment easier to sell—make it more profitable to your dealers and you — make you more friends.

THERE'S A GOODYEAR BATTERY Now!

THE GOODYEAR TIRE & RUBBER CO., INC., AKRON, O.



The Goodyear All-Traction Tire is the only tractor tire that gives traction in all directions—forward, backward, on hillsides—sure-footed in mud, sand, on the highway.

The Goodyear Implement Tire was specially built for the farm equipment that tractors pull. It rolls easily without sideslip. It cuts fuel costs—multiplies other tractor tire advantages.

GOODYEAR ALL-TRACTION TRACTOR TIRE

AND THE SPECIAL IMPLEMENT TIRE FOR ROLLING FARM MACHINES

Ohio Graduates First Student from Professional Course in Agricultural Engineering

PAUL A. LOISELLE was graduated from Ohio State University, at the end of the autumn quarter in December 1936, with the degrees of bachelor of science in agriculture and bachelor of agricultural engineering. These degrees were conferred by the graduate school of the University, and were the first conferred under the University's new five-year professional curriculum in agricultural engineering.

G. W. McCuen, chairman of the agricultural engineering department at Ohio State University, indicates that, so far as they have been able to determine, this is the first award of the degree, bachelor of agricultural engineering, for the completion of a regular five-year professional course in agricultural engineering.

Washington News Letter

(Continued from page 124)

Over two hundred sanitary engineers were assigned from federal service to the Ohio and Mississippi flood regions and forty additional engineers were detailed by the state health departments at Kentucky, Ohio, Illinois and Indiana. These sanitary engineers and medical officers advised and assisted ninety-four cities and towns with a combined population of 1,401,756 people. They helped provide emergency supplies of drinking water and assisted with the restoration of sanitary water supply service in most of these cities.

It is to be regretted that the personal sacrifice and contributions made by sanitary engineers and other members of the engineering profession in this emergency has not received more publicity. Actually thousands and perhaps hundreds of thousands of lives have been saved within the last sixty days by these members of the engineering profession residing in or called to serve in flooded areas. It is hoped that the public which has been so well served by engineers in this emergency may have gained a greater appreciation of the value of engineering knowledge and experience in times of stress.

* * *

National Resources Committee has released the minutes of a joint meeting of its water resources committee with the committee on national water policy of the American Society of Civil Engineers, the American Water Works Association, Conference of State Sanitary Engineers and the American Engineering Council held in the Interior Building on September 22, 1936. A limited number of copies may be obtained from the Publication Section, National Resources Committee, Interior Building, Washington, D. C. Although this meeting was primarily for the exchange of information and opinion, it covered a wide range of such subjects as basic hydrologic data, Rio Grande joint investigation, drainage basin study, drainage and water storage programs, flood and flood control investigations, small water storage projects, western water problems, water works statistics, water and stream pollution, and the general program of the water resources committee of the national resources committee. Engineers interested in these subjects will appreciate the spirit of cooperation exhibited in this meeting and find a number of worthwhile suggestions in the minutes.

Council cannot afford to make general distribution of the National Resources Committee's report on public works planning issued in December 1936, but engineers who are interested in long range public works programs may obtain a copy and study the background for the five billion dollar public works plan submitted to Congress by President Roosevelt as a bulwark against a new depression. It recommends: (a) Formulation, adoption, and annual revision of a six-year program of federal construction, (b) adoption and annual revision of a proposed list of projects, (c) a lump sum annual appropriation under regular budget procedures for expenditure on approved projects, and (d) an allocation of these funds to appropriate construction agencies by a permanent Public Works or development agency.

It also recommends, (1) Unified plans for many-purpose projects, (2) selection and analysis of projects, (3) advance programing of public works, (4) timing of public works in relation to other efforts toward economic stabilization, (5) negotiations affecting correlation of federal activities with regional, state, and local public works, (6) construction by established federal, state, or local agencies, and (7) operation of multi-purpose projects involving more than one state or federal agency.

* * *

On February 26 the American Society of Agricultural Engineers joined the Process Industries Division of the American Society of Mechanical Engineers and the Farm Chermugic Council in sponsoring a one-day meeting on agricultural processing at Rutgers University in New Brunswick, New Jersey.

The meeting brought together the thought of chemists and physicists who originate processes for making useful products from farm grown materials; the process engineers who develop and apply the processes on a commercial scale; and the agricultural engineers who are interested in enabling farmers to deliver basic farm materials to processing plants within the required limits as to cost, physical condition, and time and quantity of delivery.

Larry Livingston, Past President of the American Society of Agricultural Engineers, presided at the morning session, Victor Wicham, Chairman of the Process Industries Division of the American Society of Mechanical Engineers took charge of the afternoon session, and H. S. H. Heck of the Department of Mechanical Engineering and E. R. Gross, Head of the Department of Agricultural Engineering of Rutgers University served as the Committee in charge of local arrangements for the meeting.

It is encouraging to see mechanical engineers, agricultural engineers and chemists unite their efforts in an attack upon common economic problems, and Council is happy to pass the news along as a suggestion for other joint programs.

* * *

Rural Electrification Administration news is the resignation of Administrator Morris L. Cooke. Mr. Cooke is reported to have resigned voluntarily to seek a rest from the burden of responsibility which the President drafted him to carry from the creation of the Rural Electrification Administration.

John M. Carmody, an editor and industrial engineer, formerly a member of the National Labor Relations Board, chief engineer of CWA and FERA, with much experience in the railroad, steel, and coal industries and in private practice, succeeded Mr. Cooke. He is being assisted by Colonel George D. Babcock of North Carolina, who was associated with Mr. Carmody in the other emergency agencies.

ASAE Meetings Calendar

June 21 to 24, 1937—Annual meeting of the Society—University of Illinois, Urbana-Champaign

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the February issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Byron T. Aasland, designing engineer, David Bradley Manufacturing Works. (Mail) 621 S. Evergreen Ave., Kankakee, Ill.

James V. Baker, extension engineer, rural lines department, Penn Central Light and Power Company, Shippensburg, Pa.

W. O. Bechman, engineer, International Harvester Co., 2626 W. 31st Blvd., Chicago, Ill.

W. J. R. Browder, graduate assistant, agricultural engineering department, Alabama Polytechnic Institute, Auburn, Ala.

John M. Burns, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 659, Rome, Ga.

H. J. Caulfield, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 413, Schulenburg, Tex.

Harvey F. Corson, agricultural service engineer, Allis-Chalmers Manufacturing Co. (Mail) RFD No. 4, Muncy, Pa.

Joe E. Cranston, International Harvester Co., 323 6th Ave., S. E., Minneapolis, Minn

Edward M. Davis, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 228 S. Prospect St., Hagerstown, Md.

E. B. Derr, district representative dairy equipment lines, International Harvester Co. (Mail) 2043 Douglas Blvd., Apartment 11, Louisville, Ky.

H. G. Edwards, associate drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 1106 W. College Ave., Jacksonville, Ill.

Gail W. Eley, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 66 Brinckerhoff Ave., Freehold, N. J.

Glenn L. Ellithorpe, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp SCS-5, Ottawa, Kansas.

V. B. Fredenhagen, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Ottawa, Kans.

John T. Gaillard, Jr., junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box No. 367, Wetumpka, Ala.

G. Price Grieve, engineering aide-soil erosion technician, Soil Conservation Service U. S. Department of Agriculture. (Mail) Sigourney, Iowa.

Frederick F. Hollier, Jr., engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box No. 73, Ville Platte, La. *(Continued on page 128)*

SOY-BEANS REPLACE OATS

DIESEL RD4 "LEVELS" NEW "WORK PEAK"!

Fall Plowing Completed on Time

ON MANY Corn Belt farms, an increase in soy-bean acreage means a corresponding reduction in acreage formerly planted to oats.

The oat crop, harvested and threshed by August 1st, allows August-September for plowing.

But the soy-bean crop matures and requires harvesting about the same time as the corn crop. Result: a new "work peak"—to Fall plow in the limited time available.

That's one main reason why Prussner Brothers, Reddick, Ill., bought a "Caterpillar" Diesel RD4 Tractor for their 640 acres. "The Diesel RD4," writes Elmer Prussner, "gives us the power to do the Fall plowing in the short time between soy-bean harvest and the freeze-up — and we've found that the Fall plowing gives us 5 to 10 more bushels per acre on next year's crop. Our Diesel RD4 also saves three-fourths on fuel. We do our own work, and still have plenty of time to earn extra money plowing for neighbors."

CATERPILLAR TRACTOR CO. PEORIA, ILL.

REG. U.S. PAT. OFF.

WORLD'S LARGEST MANUFACTURER OF DIESEL ENGINES, TRACK-TYPE TRACTORS AND TERRACERS

Applicants for Membership

(Continued from page 126)

Clark H. Jenson, planning engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Getesville, Tex.

R. E. Jezek, engineering assistant, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) department of agricultural engineering, Iowa State College, Ames, Iowa.

J. H. Johnson, engineering aide, Soil Conservation Service. U. S. Department of Agriculture. (Mail) SCS-T-21, Brownwood, Tex.

Ormann R. Keyser, county agricultural agent, Post Office Building, Canton, Ohio.

Ira L. Knox, agricultural engineer, Tennessee Electric Power Co., 718 Power Bldg., Chattanooga, Tenn.

F. A. Kummer, assistant in agricultural engineering, agricultural engineering department, Alabama Polytechnic Institute, Auburn, Ala.

James C. Lyke, transitman, U. S. Resettlement Administration, Black River Falls, Wis.

George E. Mullin, Jr., rural electrification section, General Electric Co., Schenectady, N. Y.

Weldon O. Murphy, sales engineer, Parsons Co., Newton, Iowa. (Mail) 603 N. 2nd Ave. E., Newton, Iowa.

O. E. Olson, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Sigourney, Ia.

H. E. Pierce, assistant division commercial manager, Oklahoma Gas & Electric Co., Ardmore, Okla.

Frederick M. Poole, camp superintendent, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Box 386, Frankton, Ind.

John W. Rockey, junior agricultural engineer, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

John H. Scoltock, junior engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 605 N. 1st St., Winterset, Iowa.

B. C. Small, graduate assistant, agricultural engineering department, Alabama Polytechnic Institute, Auburn, Ala. (Mail) 303 Sanford Ave.

Lawrence E. Sommers, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 19 N. 6th St., Temple, Tex.

Wallace Stewart, sales and service departments, International Harvester Co. (Mail) 224 S. Cedar St., Charlotte, N. C.

Charles N. Stone, vice-president, Deere & Co., Moline, Ill.

L. F. Thompson, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 901 6th St., Durham, N. C.

Burnett Ware, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 248, Wolfe City, Tex.

Franklin H. Wilson, regional chief, social and economic section, Resettlement Administration, U. S. Department of Agriculture. (Mail) 800 McKinley Ave., Oakland, Calif.

Carroll E. Withers, extension engineer, agricultural engineering extension service, State College, N. Mex.

Alvah E. Worth, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 129 N. Broad St., Norwich, N. Y.

Student Branch News

Iowa Student Branch

THE Iowa Student Branch of ASAE started off the year in good shape. As in the past, the regular monthly meetings are held jointly with seminar class, which is a required course for juniors and seniors. At these meetings the regular business of the Branch is taken up; papers are presented and discussed each week.

The first regular meeting of the year was the annual agricultural engineering mixer, which was held October 22 in the Memorial Union. There were about seventy-five present. The evening began with a general introduction of students and faculty. This was followed by a dinner given by the faculty. After dinner, with President Orville Fox acting as toastmaster, talks were given by Lawrence Skromme, senior, Dr. J. B. Davidson, and William Test, a graduate student from South Dakota. Mr. Skromme talked on the ASAE meeting at Estes Park, Colorado. Dr. Davidson's talk was on the world power conference, which he attended last September at Washington. The subject of Mr. Test's talk was "Impressions." These were followed by piano and saxophone solos given by student members Harold Hansen and David Poor, respectively.

The second meeting was held November 18, with about twenty present. Charles Thomas, treasurer of the Branch, reviewed the requirements for membership in the Branch. An interesting talk on bacteria was then given by Dr. Levine, of the bacteriology department.

Our third monthly meeting was held January 21. About twenty-five members were present. At this meeting the committee was elected for the "Ag Engineering Field Day," which is held each year during the spring quarter. Mr. Peterson, of the soils department, gave a talk on the subject of culture. Refreshments were served to close the meeting.

In addition to these meetings, about ten members attended the winter meeting of the ASAE at Chicago and visited different concerns of interest there.

During the evening of February 9, a dinner was given for Mr. Turner, of International Harvester Co., and a vice-president of the ASAE. After dinner Mr. Turner gave an interesting talk on summer training courses for undergraduate students. This was followed by a round table discussion.—*Gordon Guyman, Secretary.*

Kansas State Student Branch

THE Kansas State Student Branch of ASAE has just completed one of its best semesters since its beginning. The Branch consists of 50 students, out of an enrollment of 75 agricultural engineers in the College, with an advisory committee of five faculty members.

Our Branch started off the year with its annual fall picnic on October 1. Everybody got acquainted and we all had lots of fun, especially since the picnic was furnished by faculty members. At that time William Warner gave a report of the ASAE meeting in Estes Park, Colorado, last summer.

C. E. Ghormley. who graduated from our department in 1931 and is now connected with the Soil Conservation Service in Iowa, gave a seminar talk on November 5. He discussed the soil conservation work in Iowa. Another interesting outside speaker was Prof. J. A. Hodges of the agricultural economics department, who recently compared the tractor and horse on Kansas farms. He gave some very interesting figures on the relationship.

Our organization has been meeting each Thursday afternoon as a seminar group. Most of the meetings this past semester have been taken up by talks given by our seniors. Such seminar talks dealt with the field of agricultural engineering from problems in terracing to diesel tractors and fuels. All of these talks have been interesting, besides having furnished useful information. Prof. F. C. Fenton and E. L. Barger gave interesting reports on December 10, of the ASAE meeting in Chicago November 30 to December 4. Also a word about the ASAE meeting at Urbana, Illinois, next summer was mentioned.

Eleven seniors, and Profs. Fenton and Barger, made an annual inspection trip to Kansas City and Bethany, Missouri, and Atchison, Kansas, for about a week during the early part of November. Most of the trip was taken up by inspection of soil conservation work, implement houses, and the process of making tractor fuel from corn.

I believe that it is proper to pay tribute at this time to Howard McFillen of our Branch who passed away on the morning of January 5. His death is a great loss to our Branch.

Hy Rothganger, '37, served as president of the Branch last semester. We all thank Hy for the fine work that he has done and are now looking forward to a successful semester under the leadership of "Chuck" Kent, '37.—*John D. Dietrich, Secretary.*

Virginia Student Branch

OUR first meeting for the new year was held on January 7. An interesting talk was given by our president on new developments in fertilizer placement research. This talk was followed by a short talk on the process of curing hay by dehydration.

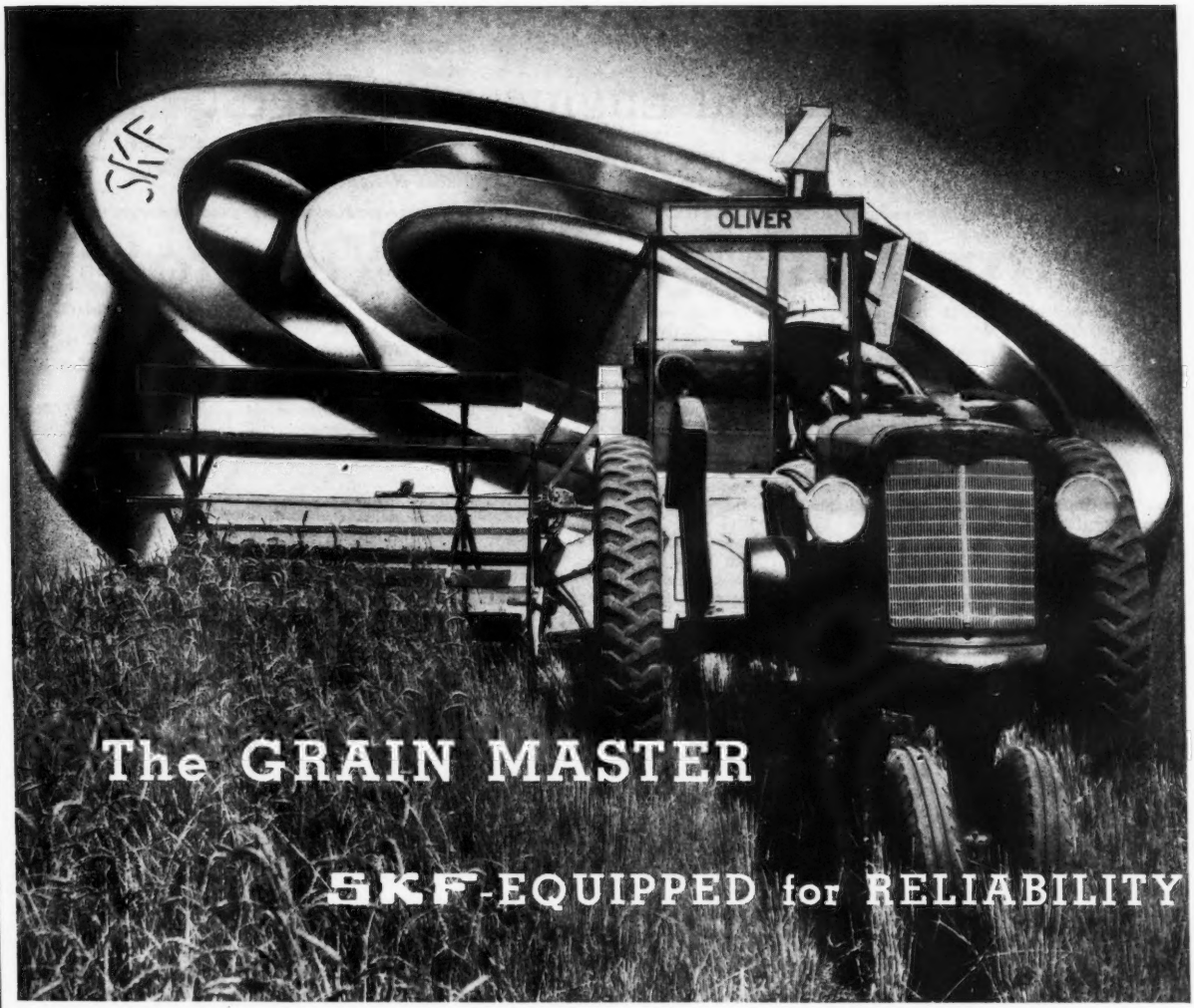
Work has been started on our publication, which is due to be available about April 10. A prize of a Branch pin was offered to the underclassman writing the best article for this publication.

The second meeting was opened and presided over by the vice-president. Talks on the following subjects were given: application of sulphuric acid to weed control, rat control, and the effect of tractor tire size on drawbar pull.

A retake of the picture of the Branch was taken for the "Bugle," the college annual.

Canning snap beans, termites, and new refrigerants were the subjects of speakers at the third meeting. It was decided at this meeting to collect and keep all the issues of the "AGRICULTURAL ENGINEERING," and to have them bound periodically, to keep as references in the seminar room in our new building.

At the last meeting of the month a talk was given on the burning of lime in southwest Virginia. The speaker told how farmers had cut down the costs of liming by burning it on their farms. Our faculty advisor informed us at this meeting of proposed plans to take a short movie of the activities of the student branches of the various schools, these movies to be combined with the one taken in Estes Park at the meeting last June.—*S. P. Marshall, Jr., Scribe.*



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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

CAPILLARY CONDUCTIVITY MEASUREMENTS IN PEAT SOILS, *L. A. Richards and B. D. Wilson*. Jour. Amer. Soc. Agron., 28 (1936) No. 6, pp. 427-431, figs. 2. In a contribution from the [New York] Cornell Experiment Station an apparatus of improved design, which was used in measuring the capillary conductivity of water in peat soils, is described.

At low tensions the soils were found to possess capillary conductivities greater than those that have been reported for mineral soils. However, the capillary conductivity was found to become zero at lower tensions in the two peat soils studied than has been reported for mineral soils.

Difficulty was experienced in measuring the capillary conductivity of peat soils because of the length of time required for the moisture content of the soils to reach an equilibrium value at a given capillary tension.

TESTS ON THE STRENGTH OF BEAMS NOTCHED IN VARIOUS WAYS, *I. Langlands*. Jour. Council Sci. and Indus. Res. [Austral.], 9 (1936), No. 2, pp. 88-96, figs. 2. Three series of tests on long and short beams of Australian timber are reported, one on 4x2-in specimens designed to fail in shear even when not notched and the others on 4x2-in and 3x2-in specimens of such length that they would normally fail in bending.

It was found that notching the ends of beams and joists seriously affects their strength. It is therefore advisable not to notch the ends of a joist or beam whenever it can be avoided. The reduction in strength can be obtained with fair accuracy from USDA Forest Service formula. If it is necessary to notch the beam its strength can be about doubled (or under certain conditions even brought up to the strength of an unnotched beam) by cutting away the bottom portion of the beam at the notch by means of a slanting saw cut with a slope of about 1 in 3 to the axis of the beam.

LOGGING—TRANSPORTATION, *N. C. Brown*. New York: John Wiley & Sons; London: Chapman & Hall, 1936, pp. XV + 327, figs. 167. This is a treatise on the principles and practice of log transportation in the United States and Canada.

Part 1, relating to minor transportation and log assemblage. contains chapters on animal skidding, tractors, power logging—cable hauling systems, and combined minor and major transportation.

Part 2, relating to loading for transport, contains chapters on landings and loadings.

Part 3, relating to major land transportation, contains chapters on chutes, wheeled vehicles—animal and tractor draft, sleds, motor vehicles, and forest railroads.

Part 4, on major water transportation, contains chapters on floating and driving; river, bay, and lake rafts and booms; ocean rafts; flumes; and barges and steamers.

THE MEASUREMENT OF THE FLOW OF AIR THROUGH TIMBER SEASONING STACKS, *W. L. Greenhill*. Jour. Council Sci. and Indus. Res. [Austral.] 9 (1936). No. 2, pp. 128-134. figs. 4. A method of measuring the air velocity through timber stacks by means of a vane anemometer is described. Correction factors, which, for any particular type of anemometer, were found to depend on the thickness of the timber and of the separating strips, on the velocity of the air, and on the position in which the anemometer is held, have been determined for a number of cases.

PUMP IRRIGATION AT THE NORTH PLATTE EXPERIMENTAL SUBSTATION, *H. E. Weakly*. Nebraska Sta. Bul. 301 (1936), pp. 12, figs. 2. This bulletin reports the results of work dealing with pump irrigation in the production of crops under conditions approximating general farm practices at the North Platte Experimental Substation. The data presented have been accumulated under conditions which would make them of value as an indication of what might be expected from pump irrigation under similar conditions and general farm practices. The results from the earlier years of this work have been published previously in Nebraska Experiment Station Bulletins 227 and 271.

Cost data for 11 seasons of irrigation pumping are summarized.

PUBLIC ROADS, April, May, and June 1936. U. S. Dept. Agr., Public Roads, 17 (1936), Nos. 2, pp. 21-43 + [1], figs. 21; 3, pp. 45-68 + [1], figs. 23; 4. pp. 69-88 + [2], figs. 17. These numbers of this periodical contain data on the status of Federal-aid highway projects, 1936 funds, current status of U S Works program highway and grade-crossing projects, and U S Public Works road construction, all as of March 31, April 30, and May 31, 1936, respectively, and the following articles:

No. 2.—The New Hampshire Financial Survey, by E. Church (pp. 21-37, 40), and Dimensions of Testing Equipment Affect Hubbard-Field Stability Values, by J. T. Pauls (pp. 38-40).

No. 3.—Stabilized Soil Roads, by C. A. Hogentogler and E. A. Willis (pp. 45-65).

No. 4.—Circular Track Tests on Low-Cost Bituminous Mixtures, by C. A. Carpenter and J. F. Goods (pp. 69-82), and Indexes of Highway Construction Costs (pp. 83-85).

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW HAMPSHIRE STATION, *W. T. Ackerman, H. C. Moore, G. M. Foulkrod, T. B. Charles, A. E. Tepper, F. D. Reed, and K. W. Woodward*. New Hampshire Sta. Bul. 289 (1936), pp. 20-24. The progress results are briefly presented of a rural electrification survey in New Hampshire and of investigations on precooling of milk, heat requirements for brooding chicks, pneumatic tractor equipment, and fence post durability.

ELECTRIC REFRIGERATION AND AIR CONDITIONING. Lubrication, 22 (1936), No. 6, pp. 61-72, figs. 19. This is a technical discussion of different types of home refrigeration.

THE RELATION OF COLLOIDS IN SOIL TO ITS FAVORABLE USE IN PISE OR RAMMED EARTH WALLS, *R. L. Patty*. South Dakota Sta. Bul. 298 (1936), pp. 23, figs. 13. This bulletin summarizes the important results of studies in progress at the station for several years on rammed earth as a structural material and refers particularly to recent studies on the soil colloid relationships.

It has been found that a soil low in colloids is favorable for pisé walls and resists weathering action well. A soil that tests high in colloids is unfavorable for the purpose. A test for colloids not only identifies the soil as being favorable or unfavorable. but it indicates just how favorable it will be. The quality of the earth wall will vary inversely with the colloids in the soil. as revealed by the analysis.

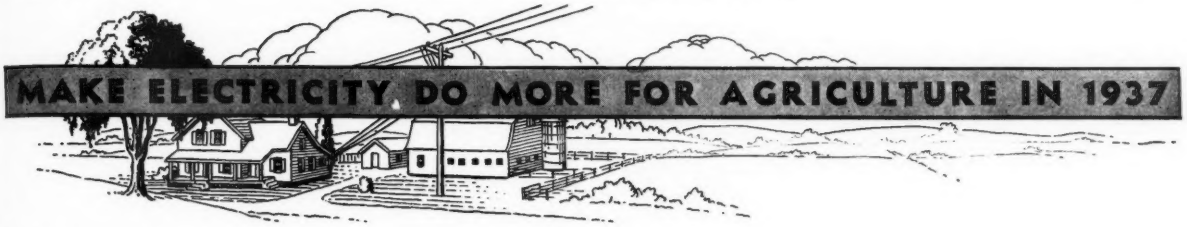
The hydrometer method of soil analysis was found to lend itself well to work with earth walls. With this method the colloidal content of a soil can be obtained in 40 min after the sample has been dried to constant weight. Heavy clay soils high in colloids were found to be unfavorable for rammed earth walls, and light sandy soils low in colloids were very favorable for the purpose. The dividing line between favorable and unfavorable soil was found to be a colloidal content of 40 per cent. Soils containing more than 40 per cent colloids are not fit to use as they are, and in few cases can such soils be made satisfactory for the purpose by adding a reasonable amount of sand or by special protective coverings.

Silt seems to be more favorable in a soil than does clay. Although no uniform ratio is shown between the silt content and the quality of the wall, it is apparent that silt is generally favorable. It is also true that a silty soil makes an excellent wall when sand is artificially added.

Sand is distinctly favorable in a soil for pisé work. Sandy soil resists weathering, rams much more quickly, holds protective coverings well, and probably will hold oil paints. It was found that no soil containing less than 80 per cent sand is too sandy for the purpose.

Foundations for pisé walls should extend from 12 to 15 in above the ground except in cases in which cement stuccoes are used for coverings, in which case 9 in may be sufficient. Rammed earth increases in strength with age in the same way as does concrete. The average increase in strength was 45 per cent over a period of 2 yr.

(Continued on page 140)



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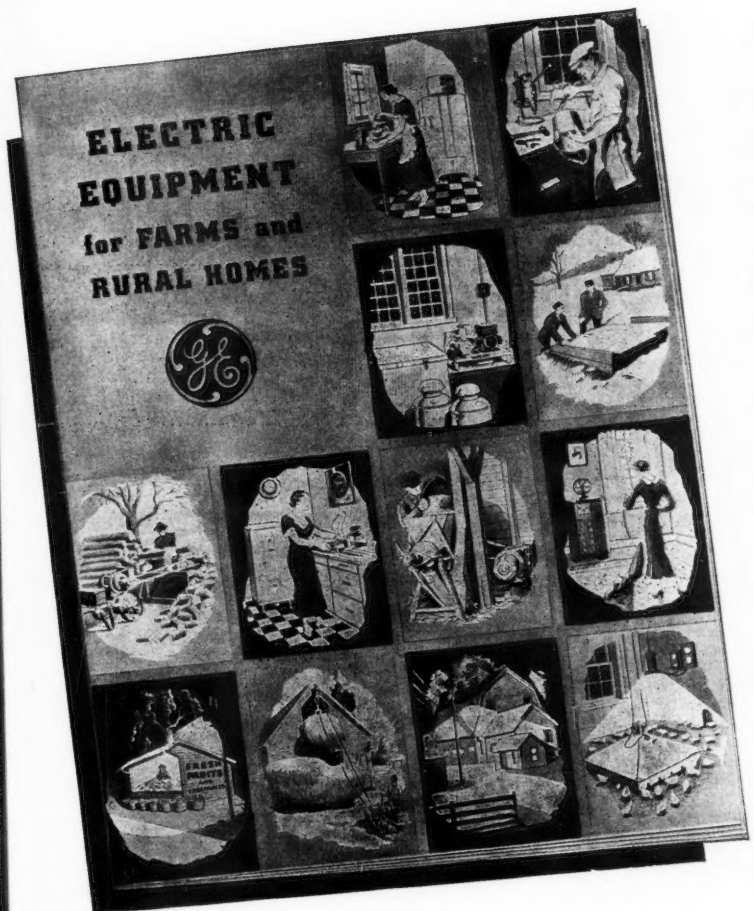

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Agricultural Engineering Digest

(Continued from page 130)

STUDIES ON THE USE OF THE TERRACING PLOW FOR SOIL CONSERVATION, *H. J. Harper.* Jour. Amer. Soc. Agron., 28 (1936), No. 4, pp. 301-309, figs. 3. Studies at the Oklahoma Experiment Station on the terracing plow are reported the purpose of which was to determine its limitations in a soil conservation program.

It was found that the effective height of terrace ridges could be increased by plowing twice in the same furrow for three or four rounds. When a riding plow is used a deep, narrow furrow slice should be moved toward the terrace ridge. A moldboard designed with the outer end flattened and bent slightly to the rear at a point about 22 in from the edge of the landside will operate easier along crooked furrows in soil where sods are frequently encountered and in soil which tends to stick near the end of a straight moldboard.

The draft of a terracing plow is very similar to that of a general-purpose plow when operating under similar conditions. A plow operating in subsurface soil required about twice as much power as the same plow operating in surface soil. When terrace ridges are being constructed with a terracing plow the land should be planted to small grain or some other crop which will cover the surface of the ground and reduce the erosion which may occur from breaks in the low ridges, unless the ridges can be plowed two or three times during the fall or winter in order to increase the effective height. When row crops are grown the rows should be planted on a contour and parallel with the terrace ridge. The terracing plow was more useful than a backfilling plow or an ordinary plow in gully control work where soil is removed from the upper edge of a bank in order to establish a more vigorous growth of vegetation in the bottom of the ditch.

THE PARSHALL MEASURING FLUME, *R. L. Parshall.* Colorado Sta. Bul. 423 (1936), pp. 84, figs. 30. A description is given of this flume, together with the results of laboratory and service tests, and tubular discharge data.

The Parshall measuring flume has shown in field operation that it is practical under conditions which make a standard weir or rating flume impractical, either because of silting trouble or insufficient grade. The accuracy of measurement with this device is entirely within practical limits. The observed discharge, free flow, was within 3 per cent of the computed amount in 89 per cent of the tests. For the submerged flow, 85 per cent of the observed discharges were within 5 per cent of the computed amounts. The range of capacity of discharge from a minimum of less than 0.1 sec-ft through the 3-in flume to a maximum of 1,500 sec-ft through the 40-ft flume, as limited by present investigations, is sufficient to meet ordinary requirements. This device operates successfully with relatively small loss of head, and for free flow this loss in a standard weir is approximately four times that in the flume. The flume will withstand a high degree of submergence without affecting the rate of free-flow discharge, and for this reason it is recommended that the throat-gage stilling well be provided to obtain the full efficiency of the flume. Because of the increased velocity of the water it will operate successfully in sand- or silt-laden streams. Since the floor of the structure is constantly swept clean of all deposit, constancy of condition is maintained.

Operation is simple because it has no adjustable or moving parts. Its dimensions are not easily altered so as to cause wilfully unfair measurement of the discharge. The filling of the weir box upstream from the crest, by natural deposit from the stream, causes the weir to over-register, and consequently there is no incentive on the part of the water user to correct this condition. Discharge through rating flumes may be changed to the advantage of the user by altering downstream conditions. Velocity of approach of the stream to the entrance of this device has little or no effect upon the rate of discharge. Plane surfaces in the structure make it easy to construct. For moderately large flows the upper ends of the converging section should be rounded off by means of sheet metal pieces rolled to a radius of 4 or 5 ft. The structure may be built of wood, concrete, or sheet metal. Precast concrete members may be made and assembled in the field for the small-sized flumes. Sheet metal flumes, portable because of their light weight, are entirely practical for the small sizes.

Recording instruments may be operated in connection with this device to register heads or total discharge. Where the degree of submergence exceeds about 95 per cent, the indicated discharge through the flume is not wholly dependable. If conditions permit, the discharge should be free flow or with the least possible degree of submergence. For free flow, the flume's measurement of discharge depends upon a single head or depth only, it being similar in this respect to a standard weir or rating flume. The upper head in the converging section, or the throat head, may be read on either side of the flume with equal accuracy. Scales or gages attached to the inside of the flume for the purpose of determining the head are not recommended except for small flows or moderate depth and free-flow condition. Better results are obtained if the heads are observed in stilling wells outside the structure. For free flow the exit velocity is relatively high, and bottom as well as bank protection must be provided to prevent erosion. Where the materials are of such a nature as to withstand a high velocity, such as heavy gravel or rock, no attention need be given to protection.

The Parshall measuring flume has the advantage over the old type of Venturi flume in that the angles of convergence and divergence are such as to eliminate the effect of the switching of the current in the diverging section, which, in the old flume, affected the discharge.

TREATMENT OF NATIVE WOODS FOR POSTS. Connecticut [New Haven] Sta. Bul. 381 (1936), p. 184. Experiments on the open tank creosoting of native posts are briefly reported.

It was found that oak is quite readily impregnated to a depth of 0.25 in at the ground line if immersed in creosote at a temperature of 215 to 220 F (degrees Fahrenheit) for from 4 to 6 hr, depending on the degree of seasoning. Unless the tops of the posts are to be painted, they should be dipped for from 5 to 10 min in hot creosote to disinfect cracks or holes which, by forming water pockets may become breeding spots for rot fungi. Red maple and birch can be impregnated to a depth of 0.25 in at the ground line with a prolonged hot bath of 12 hr or more, but with this duration of bath the butts absorb an excess of preservative that serves no useful purpose and very materially increases the cost of treatment. To overcome this difficulty, posts of these species were perforated with a toothed hammer for 6 in above and 18 in below the ground line. This made it possible to secure the required penetration with an immersion of from 4 to 6 hr at 215 to 220 F, and without excessive butt absorption.

These treatments are for round, seasoned, peeled posts with the sapwood intact and are not applicable to sawed material. The preservative used was grade 1 coal tar creosote.

A number of species check severely during seasoning, causing a heavy loss by the culling out of otherwise satisfactory posts. Such checking is negligible in oak and heaviest in red maple and birch.

GARDENING BY ELECTRICITY, "Trician" Rural Electrif, and Electro-Farming, 11 (1936), No. 133, pp. 407-409, figs. 3. Application of electricity to small-scale gardening operations in England are briefly described.

A "TWO-WAY" CANDLING AND GRADING BENCH FOR USE IN EGG PACKING PLANTS, *E. R. Menefee.* Poultry Sci., 15 (1936), No. 2, pp. 125, 126, fig. 1. In a brief contribution from the Indiana Experiment Station, a description is given of a grading and candling device which is used in several Indiana packing plants where eggs are being graded under the U S Government standards.

AGE-STRENGTH RELATIONSHIP FOR RAMMED EARTH, *R. L. Patty.* Engin. News-Rec. 117 (1936). No. 2, p. 44, figs. 2. Tests conducted at the South Dakota Experiment Station on the relation of age to the strength of rammed earth are briefly reported.

In the tests three base soils were used and 12 test blocks were made from each soil on the same day and from the same pile of earth. The first was a very heavy clay soil, the second a medium sandy soil, and the third a very sandy soil. At the end of 6 mo four blocks of each soil were tested to failure, at the end of 1 yr four other blocks of each of the soils were broken, and at the end of 2 yr the final four blocks of each soil were broken. Upon averaging the strength of each group of test blocks an increase in strength was shown in the case of each soil. At the end of 1 yr the average increase in strength over the 6-mo test blocks was 33.7 per cent, and at the end of 2 yr the average increase in strength over the 6-mo blocks was 45 per cent.

It was noted that the heavy clay soil had the greatest early strength. It was still first in strength at the end of 2 yr, but the results showed that the sandier soils gained more strength with age. Clay soil is not a favorable soil for pise walls in spite of its superior strength, because it has a tendency to slake in the wall and does not resist the action of weathering as well as the soils containing less clay. Of the three soils used in this strength test, soil containing 74.82 per cent of sand made the best wall.

OPERATING SMALL SAWMILLS, METHODS, BIBLIOGRAPHY, AND SOURCES OF EQUIPMENT, *C. J. Telford.* U. S. Dept. Agr., Forest Serv. Forest Prod. Lab., 1936, [2] + 40. This is a technical treatise on financing and operation of logging and milling outfits, with information on timber appraisal and marketing. A list of manufacturers of dry kilns, sawmills, and accessories in the United States is included.

(Continued on page 142)

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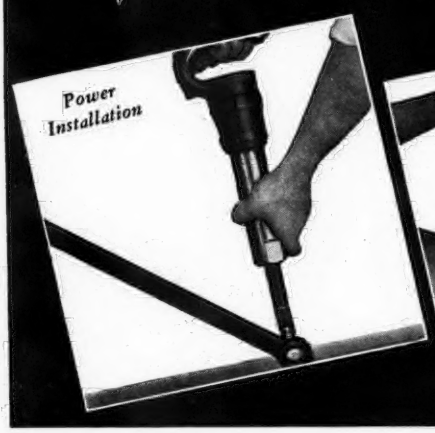

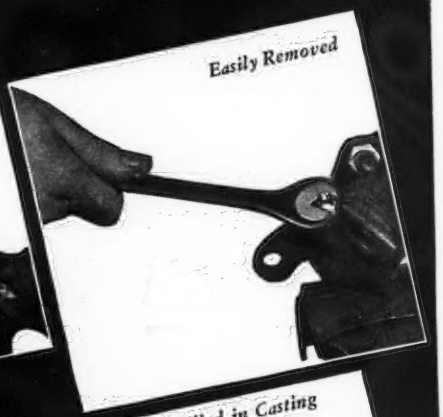

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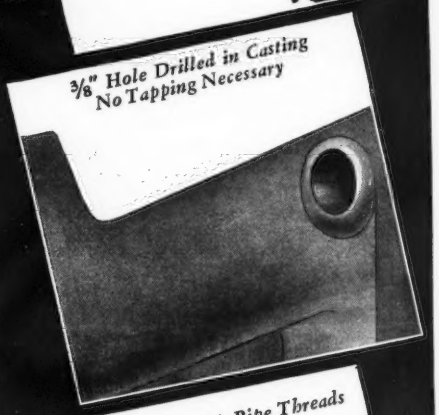

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Agricultural Engineering Digest

(Continued from page 140)

CYLINDER WEAR IN GASOLINE ENGINES, *C. G. Williams.* SAE [Soc. Automotive Engin.] Jour., 38 (1936), No. 5, Trans., pp. 191-196, figs. 8. This paper covers work carried out by the Research and Standardization Committee of Cylinder Wear in gasoline engines. The experiments were carried out on a number of single-cylinder units of 3⅜-in bore, which can be fitted with either water-cooled or air-cooled barrels, and direct measurements of bore wear made by means of gages, piston-ring wear being measured by weighing. All readings of bore wear were taken at the top of the ring track where wear is a maximum, and the readings are expressed in equivalent wear per 1,000 miles of road operation.

Attention is drawn to the importance of corrosion under cold-running conditions. This importance was discovered through a systematic study of the effect of several different variables, showing that below certain cylinder-wall temperatures there was a very rapid increase in wear. The study was confirmed by observations on the stained or pitted appearance of the cylinder walls and piston rings of engines which had run at low cylinder-wall temperature, the presence of relatively large quantities of water in the lubricating oil under such operating conditions, the fact that the sudden increase in cylinder wear occurred when the cylinder-wall temperature approximated the calculated dew point or condensation temperature of the products of combustion at the pressure existing during the combustion cycle, and that the use of corrosion-resisting materials, namely, austenitic cast iron, for piston rings and cylinders effects a considerable reduction in wear under low-temperature conditions.

The importance of thermostats in reducing cylinder-liner wear is shown, as is also the rapid increase in wear with increasing mean effective pressure and cold-running conditions.

It is concluded from the result of the experiments on lubricants that pure medicinal paraffin gives inadequate protection from corrosion under cold-running conditions and that the presence of a fatty acid or fatty oil is necessary under such conditions. At high cylinder-wall temperatures representing abrasive conditions pure medicinal paraffin gave a very low rate of wear that was approximately the same as that of commercial lubricant, and various additions of fatty oils to the pure medicinal paraffin did not effect any marked improvement in wear.

The effect of increasing skirt clearance from 0.0058 to 0.0300 in on the wear of the top piston rings was quite marked, while the effect on cylinder wear was much less appreciable. The effect of radial piston ring pressure was not of great importance, particularly within the range of pressure usually met with in practice. The effect of increasing piston ring width from 3/64 to 3/16 in at high cylinder-wall temperature, that is, under abrasive conditions, was quite important, the rate of wear with the narrower rings being from five to seven times greater than that with the wide rings.

AMERICAN FARM BUREAU FEDERATION, INSTITUTE OF IRRIGATION AGRICULTURE, FIFTH ANNUAL CONFERENCE, SALT LAKE CITY, MAR. 11-13, 1936. Chicago: Amer. Farm Bur. Fed., 1936, pp. [4] + 82 + 16. This institute included, among others, special papers on Basic Information Relating to Hydrology of the Region West of the 100th Meridian, including a Study of Methods and Results of Snow Surveys, by G. D. Clyde; How the Great Plains Area is Meeting the Problems of Irrigation Pumping, by G. S. Knapp; A Committee Report of Recent Research and Investigational Work on Irrigation and Drainage in the Western States, by W. W. McLaughlin. C. S. Scofield, and O. W. Israelson; Practical Irrigation Problems on Which Farmers Need Assistance, by W. Peterson; A Study of the Preferential Rights in the Use of Water and Their Relation to Agriculture and of Authority for Enforcement, by G. E. P. Smith; A Critical Study of the Recommendations of the National Resources Board, by R. B. West; and The Place of Reclamation in the National Agricultural Program, by M. L. Wilson.

RESEARCH IN IOWA IN SOIL EROSION, SOIL CONSERVATION, AND RELATED LAND USE PLANNING, *R. E. Buchanan.* Iowa Sta. 1936, pp. [2] + 47. This mimeographed publication outlines the manner of organization and coordination of the research program in soil erosion control, soil conservation, and related land-use planning in Iowa, enumerates the research projects being actively pursued in these subjects, and presents a program of additional research, by projects, considered essential to the success of soil conservation and land-use practices in the state.

PARTIAL LIST OF GOVERNMENT PUBLICATIONS OF INTEREST TO ARCHITECTS, BUILDERS, AND RETAIL LUMBERMEN. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1936, pp. 16. This mimeographed list relates mainly to fungus defects in forest products; the growth, structure, and identification of wood; manufacture and grading of lumber; mechanical properties and structural uses of wood and wood products; the seasoning of wood; wood finishing subjects; and wood preservation. *(Continued on page 144)*

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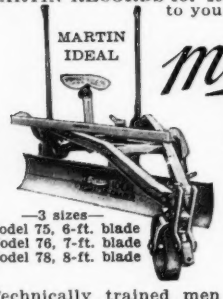

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Agricultural Engineering Digest

(Continued from page 142)

FARM BUILDINGS, *J. C. Wooley*. Columbia, Mo.: Univ. Coop. Store, 1936, pp. [6] + 266, figs. 221. This publication is a compilation of information on farm structures and some of the science directly related. The subject matter is presented with the idea of reviewing the underlying science involved and finding its application to the conditions imposed by the different structures.

It is divided into chapters on the development of farm buildings in America; the function of buildings in the business of farming; heat—its production, measurement, and transfer; heat transfer through separating mediums; heat relationship in farm buildings; moisture in farm buildings; the comfort zone; ventilation systems; mechanics of farm buildings; design of structural members; barn frames; gable—combination and shed rafters; gambrel, gothic, and hip rafters; wood as a building material; concrete; brick blocks and steel; cobblestone, rammed earth, and log construction; siding, roof covering, and insulating material; location and planning the farmstead; machinery storage and repair buildings; planning buildings for the dairy enterprise; dairy barns and milk houses; silos; buildings for the poultry enterprise; buildings for the hog enterprise; beef cattle and sheep barns; horse barns and general-purpose barns; grain and hay storage buildings; storage structures for fruit and vegetables; the farm home; heating the farm home; water systems; disposal of waste from the home; remodeling, care, and repair of buildings; cost of new and appraisal of old buildings; fencing the farm; and drafting and interpretation of plans.

THE EFFECT OF GAS PRESSURE ON PISTON FRICTION, *M. P. Taylor*. SAE [Soc. Automotive Engin.] Jour., 38 (1936), No. 5, Trans., pp. 200-205, figs. 9. The effect of gas pressure on piston friction was investigated in the laboratory of the Massachusetts Institute of Technology by driving with an electrical dynamometer a 6-cylinder engine with the valves removed and the valve-stem bushings plugged. Air under pressure was admitted to the closed space made up of the cylinders, valve passages, and manifolds, and a constant air pressure was maintained on the pistons. Under these conditions it was found that the friction increased approximately as a linear function of the pressure and the running speed. The effect of jacket-water temperature on piston friction was marked, but it could not be directly connected with the absolute viscosity of the oil at the temperature of the jacket water. Tests run with gas pressure relieved from behind the piston rings indicated that about a fourth of the rate of increase in friction with pressure is due to gas pressure behind the rings.

Computation from the test results indicate that the increase in friction due to gas pressure on pistons, as compared with piston friction on the ordinary motoring friction test, is in the neighborhood of from 2 to 3 lb per square inch mean effective pressure for this type of engine.

Correction Notice

Attention has been called to the fact that in the paper, entitled "Control of High Soil Temperature," which appeared in AGRICULTURAL ENGINEERING for September 1936 (vol. 17, no. 9), the captions of the two figures at the bottom of page 385 were unfortunately interchanged.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

CIVIL ENGINEER, with two years agricultural engineering experience in soil conservation work, including SCS camp layout, design of small earth dams, terraces and outlets; layout of dimension ditches; drafting, blueprinting, filing, time study, general estimating; camp engineer work, including layout of field work for camp crews, general supervision of field foremen, design of erosion control structures, and preparation of reports. Also one year's experience in detailing reinforced concrete for buildings. Desires position in construction work or with machinery manufacturer in maintenance, demonstration, or research. Looking for permanent connection with opportunity for advancement. Location immaterial. Age 27. PW-272